REPORT

of the

Second Reviewing Committee

of the

Council of Scientific and Industrial Research

NEW DELHI
1954

REPORT OF THE SECOND REVIEWING COMMITTEE OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

CONTENTS

New Delhi,
3rd April, 1954

Dear Prime Minister,

I have the honour to forward herewith the report of the Second Reviewing Committee which you constituted for the purpose of reporting on the activities of the Council of Scientific and Industrial Research during the past five years.

We hope that some of the Committee's suggestions will be useful to you, Sir, and the Council of Scientific and Industrial Research.

I and my colleagues on the Committee are very grateful or all the information which Dr. Bhatnagar has supplied us, and for the excellent arrangements which made it possible to visit nearly all the laboratories.

In forwarding the report to you, I should like to state that we are greatly impressed with all that has been accomplished in these five years, so much of which is due to your personal interest and encouragement and to Dr. Bhatnagar's great zeal and energy.

I should also like to thank the Secretary, Mr. R. C. Sharma, allocated to me as Chairman whose assistance has been very valuable to me and all those in the offices of the Council, Laboratories and elsewhere who have helped to make this review a pleasurable task.

I am, Sir,
Yours sincerely,
ALFRED C. EGERTON,
Chairman,
Reviewing Committee.

Shri Jawaharlal Nehru,
Prime Minister,
New Delhi.


सत्यमेव जयते

Constitution of the Reviewing Committee and its Terms of Reference

1. We, the members of the Reviewing Committee of the Council of Scientific and Industrial Research have the honour to submit our report.

2. The Committee was appointed by the Prime Minister in his capacity as President of the Council of Scientific and Industrial Research, to appraise the researches, both pure and applied, conducted at the National Laboratories and sponsored at universities and other research institutions and suggest lines for future development and report generally on the organisation and the working of the Council of Scientific and Industrial Research. The Committee consisted of the following:

Chairman

Sir Alfred Egerton, D.Sc., F.R.S., Emeritus Professor, Imperial College of Science and Technology, London

Members

Prof. Gaston Dupouy, Director, Centre National de la Recherche Scientifique, Paris

Prof. S. N. Bose, Khaira Professor of Physics, University College of Science, Calcutta

Sir Shri Ram, 22, Curzon Road, New Delhi

Shri M. D. Chaturvedi, Inspector General of Forests, New Delhi

Shri B. R. Batra, Chief Engineer, Posts and Telegraphs, New Delhi

Sir A. L. Mudaliar, M.D., LL.D., Vice-Chancellor, University of Madras, Madras

3. The Committee had its first meeting at New Delhi on the 17th February 1954 when all the members excepting Dr. A. L. Mudaliar were present.

4. The programme of visits to the various national laboratories is given in Chapter I of the Report.

5. The Committee met again in New Delhi on the 15th, 24th and 26th March. Dr. A. L. Mudaliar and Sir Shri Ram could not attend any of these meetings. A circular was sent to all the Chairmen of the Advisory Bodies of the National Institutes and Laboratories asking them to let the Committee have any suggestions they might like to offer regarding the working of the National Laboratories and

meet the Committee for personal discussion, if convenient. Major-General Williams, Chairman, Advisory Board for the Central Building Research Institute met the Committee on the 24th March. Mr. H. P. Mathrani, Chairman, Advisory Board, Central Road Research Institute, had a personal discussion with the Chairman of the Committee. Communications giving their views were received from the following Chairmen of Advisory Boards:

1. Shri C. B. Gupta, Chairman, Advisory Board, Central Drug Research Institute
2. Sir Jehangir Ghandy, Chairman, Advisory Board, National Metallurgical Laboratory
3. Dr. Rm. Alagappa Chettiar, Chairman, Advisory Board, Central Electro-Chemical Research Institute
4. Mr. D. N. Sen, Chairman, Advisory Board, Central Glass and Ceramic Research Institute

The Committee had also an opportunity of a discussion with Prof. M. N. Saha who later presented a Memorandum to the Committee.

6. We take this opportunity of expressing our grateful thanks to all concerned, specially to Dr. S. S. Bhatnagar, D.S.I.R., who provided all the secretarial assistance, for the kindness and courtesy shown to us and for the opportunities afforded to us to get acquainted with the various aspects of the work of the laboratories.

Summary

Twelve very fine modern laboratories have been built and have been well equipped at a cost which is very reasonable. They cover a range of subjects of research in science and industry which, together with those few others for which sanction has already been given (including C.S.I.R. research association laboratories) appear to be sufficient for the next few years. Attention is drawn to some branches of science which could be helped to advance (see p. 88).

The policy of the Council to establish these national laboratories and institutes has, in our opinion, been fully justified. They have already given good service and substantial gains have been achieved. These have been recorded. Their existence will be justified to an increasing extent. Their continued success depends chiefly on the Directors and the staff of the laboratories and institutes. The Directors have been well chosen and their staff are keen and are doing good work.

The laboratories and institutes greatly widen opportunities for young research workers as well as for making use of young talent.

The scientific organisation over which the Council's activities range should be well co-ordinated and while no recommendations are made requiring reorganisation, suggestions are made whereby the present

organisation might operate even more efficiently. It is suggested that the Directors should be given as much freedom in administration as possible with more time to exercise scientific guidance. There are also suggestions whereby the activities of the Council could be directed towards those objectives most helpful to India and the progress of science.

It is recommended that the relationship of national laboratories and institutes with the universities should be given further consideration so that the whole scientific organisation can be operating in concert. The future depends to a great extent on the education by the universities of young people of high calibre to man the laboratories and to fill, while they are still in full vigour, posts of responsibility. Further use can be made of the facilities of the national laboratories by university departments for post-graduate work and help can be given to the universities by members of the staff of the national laboratories. The Board and Committee work of the C.S.I.R. can be helped by the men from the universities in active research work and their work can be assisted (and is being assisted) by grants for equipment and for research assistants provided by the C.S.I.R.

Attention is drawn to the need for attracting young engineers to undertake research work.

The Directors of laboratories and institutes are alive to the necessity of keeping in close touch with each other so that the work of the different laboratories can be co-ordinated. They are also alive to the necessity of keeping in close touch with industry. We have emphasised the importance of all this co-operation. It is recommended that it should be the duty of the Liaison Officer at the C.S.I.R. headquarters to further all such collaboration between the C.S.I.R. institutes and laboratories and organisations in which research is carried out and which are not under the Council.

It is also suggested that the work of the Executive Director and Secretary of the C.S.I.R. should be assisted in relating the activities of the Council to India's needs by an intelligence officer who would keep in close touch with the Directors of the laboratories.

It is recommended that there should be closer co-ordination and co-operation between the C.S.I.R. and the agricultural and medical research services. It is also recommended that more active co-operation should exist with government departments in order that they should make trial of and utilise (where proved effective) the results of the researches of the laboratories and institutes of the C.S.I.R. Government Departments should be an example to industry in showing such initiative.

It is pointed out that arrangements of an economic kind may be required so that new products and processes can be adopted by industry which would be to the national advantage.

In order to assist the development of processes and new products, we recommend that as much help as possible should be given to the newly formed National Research Development Corporation and that the institutes should be given what they need for their proposals for installation of pilot plants.

Research organisations supported by Government relating to industry should be as far as possible within the Council's authority.

We have noted that Research Associations, partly Government supported, have been formed and we recommend that further associations on such lines should be instituted where the size of the industry warrants this procedure. In the meantime, such laboratories as the National Physical and the National Chemical, and those institutes related to specific industries (Fuel, Glass, Leather, etc.) will serve the needs of the industry to the fullest possible extent. Industry should be encouraged to use the facilities which they provide for solving industry's problems.

We have provided a statement of the expenditure on research in certain highly industrialised countries. The expenditure by India is a long way from being on a similar scale. We have given an account of our impressions of each laboratory which we visited and made some special recommendations relating to each.

The Committee has made certain recommendations about the Boards and Committees of the Council to improve liaison between the different organisations. The Committee has also recorded and commended the many activities of the Council which we feel confident will prosper and be of great service.

Tribute is paid to the work of the Director of the C.S.I.R. who has enabled so much progress to be made in so short a time.

I

INTRODUCTION

DISEASE, famine and war have been the three evils in man's path. Science is providing means to stem the onslaught of disease; science is pointing the way to supply the material needs of men and to allay the fear of famine; science is putting the fear of God in man and making aggression less alluring. Even if for a static population the needs of men could be satisfied it would be of no avail if population increased at such a rate that famine, disease and aggression again assumed control. While science can help, science without the eternal virtues inherent in man will be of little avail. Nevertheless the self-effacing discipline of science awakens in man these very qualities. Science is then the guiding star to man's future, displacing the darkness of superstition by the light of the laws of nature.

India, observant of the developments in the past century and wise in the philosophies of a longer past, under the guidance of a great Prime Minister, has placed science in the forefront of its future plans. The Prime Minister has had the good fortune of having a scientist of great dynamic power to give effect to this decision.

Science sets no boundaries; her guidance is to humanity as a whole. The discovery of a universal law of nature, such as the laws of thermodynamics in the last century or the principle of indeterminacy in the present century, becomes the heritage of mankind, from which arise new powers to understand Nature's ways. Nevertheless, each country has its own difficulties to overcome and seeks the guidance of science to help in the solution of its problems. The careful statement of the problem needs a scientific approach and the countries which make use of science need, therefore, to have their trained scientists, laboratories and up-to-date equipment, and the atmosphere in which scientific work can be done. By solving its own problems, one country can contribute to the welfare of another: this is in accord with the spirit of science.

In assessing the work of the Council of Scientific and Industrial Research, we have to review the achievements in the light of the above generalities and in respect to India's particular problems or rather those problems which come within the province of the Council's activities.

We shall first consider the Council's work in relation to India's main problems and the general support of scientific research by the Central Government; then the administration and the achievements of National Laboratories and Institutes under the Council, and some of

the other activities of the Council, and finally make some suggestions for the future, both as regards the organisation and the programme of work.

We shall not go into much detail as this is well set out in a recent Review issued by the Council. There is also the Review of the work of the Board. We likewise need not repeat what can already be found in Chapter XXVIII of the Report of the Planning Commission (p. 412).

Our remit was "to take stock of the Council's achievements during the past five years and to consider lines on which its activities should be developed and expanded in the future."

Our first decision was, therefore, to review as many of the laboratories as possible and obtain a general impression of the work which is being done in them. A rapid inspection was all that was possible in the time available, for the laboratories are scattered wide. The following was the programme of visits between the 18th February and the 9th March 1954:

18th February	The National Physical Laboratory, New Delhi
19th February	The Building Research Institute, Roorkee
20th February	The Central Road Research Institute, New Delhi
25th February	The National Chemical Laboratory, Poona
27th February	The Central Food Technological Research Institute Mysore
1st March	The Central Leather Research Institute, Madras
3rd March	The Central Glass and Ceramic Research Institute, Calcutta
4th March	The National Metallurgical Laboratory, Jamshedpur
6th March	The Fuel Research Institute, Jealgora
8th March	The Central Drug Research Institute, Lucknow
9th March	The National Botanical Garden, Lucknow.

We have not visited the Electro-Chemical Research Institute, Karaikudi, though we discussed its work with its Director when in Madras. Neither have we visited the Salt Research Institute which is in the process of being established at Bhavnagar, nor the site of the Central Electronics Engineering Research Institute at Pilani. We have not visited the A.T.I.R.A. Laboratories and the Silk and Art Silk Mills Research Association Laboratories. We, however, made brief visits during our journeys to the Forest Research Institute, Dehra Dun, the Tata Institute of Fundamental Research, Bombay; the Bose Institute, Calcutta; the Fertilizer Factory, Sindri; the Indian Institute of Science, Bangalore; and the Raman Institute, Bangalore.

II

SCIENCE IN RELATION TO INDIA'S PROBLEMS

ALTHOUGH we are only concerned with the Council's work, it is necessary at the outset to remind ourselves of the plan which India has adopted for development during the period 1951-56.

The following table taken from page 3 of the Five Year Plan is, therefore, in some measure a guide to the development schemes under the Plan:

TABLE I

	Crores of Rs.	*Per cent*
Agriculture and community development	361	17·4
Irrigation and Power	561	27·2
Transport and Communications	497	24·0
Industry	173	8·4
Social Services	340	16·4
Rehabilitation	85	4·1
Miscellaneous	52	2·5

The purposes are:

(a) the achievement of the maximum possible increase in agricultural production;

(b) the preparation for substantial industrial expansion.

The above figures for irrigation and power and for transport and communications mainly concern the attainment of the first purpose; the figure for industry is much smaller than the total envisaged, for much of the expansion is intended to be met by private enterprise rather than through public expenditure. In this category expenditure has already increased and will probably increase further.

Science has much to contribute towards the achievement of these projects. We understand that research expenditure is only a small fraction of the 2·5% under the heading 'Miscellaneous'.

There are a multitude of applications of science to problems of agriculture and forestry, to soil conservation, to irrigation and water supply, to hydraulics and power supply, to health services, housing, transport, communications, etc. There are also possibilities, yet

unknown, of making use of the natural resources of India and of its vast supplies of solar energy and water.

As to industry, the device of suitable aids to human labour by tools and machines, the invention of new processes and the improvement of existing processes can in modern times only be achieved in close association with science and technology and all its elaborate equipage. It is not possible to outline the innumerable ways in which science can assist India's Plan, but it is, nevertheless, important for us, in reviewing India's scientific effort, to recognise that the Plan is in operation.

Although India's problems are very different to those in highly industrialized countries, such as U.S.A. and U.K., for the extent to which industrialisation has so far occurred is very different, yet it is well to note what the expenditure on research and the general organisation of the scientific effort is at present in those countries.

The industries of the United States are highly developed and scientific research in relation to the industries is mainly concentrated in the various industrial concerns. This facilitates the trial and rapid development of new processes and products.

The Federal Government, nevertheless, spends quite lavishly on research; the expenditure is predominantly for defence purposes, but recently further expenditure has been allocated to fundamental research.

The National Science Foundation was established by Congress inter alia to "develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." The Foundation's analysis of Federal expenditure on research and development shows that in 1953, out of a total expenditure of nearly $2,200 millions, 73% was sponsored by the Defence Departments. This does not include the $292 million expenditure of the Atomic Energy Commission (13·4%) nor the $76 million of the National Advisory Committee for Aeronautics (3·5%), both of which largely concern problems of national defence. "Nine out of ten dollars which the Federal Government spends for research and development originates in the need for adequate defence." The N.S.F. estimate that 25% of the funds are used to pay for work performed in Government-owned installations, 15% for work sponsored at non-profit institutions (universities, etc.) and 60% for work sponsored at profit organisations (industrial laboratories, etc.). Nearly 50% of the total research work carried out by industry is financed through the Government expenditure on research. The industries which spend most on research are the electrical, aircraft and chemical manufacturing industries; the cost of research as a percentage of sales is by far greatest for the aircraft industry and is followed by that of the

electrical and scientific instruments industries. (Although petroleum refining depends significantly on research, the percentage cost is low because of the high value of the sales). The report contains interesting figures relating to the number of professional research staff employed in the various industries. There are 20 companies which employ professional graduate research staff of over 1,000. The U.S. Government's support of 'basic' research was only about 6% of the total expenditure on research but it must be remembered that part of the total expenditure has a direct effect on the amount of basic research which is done.

In the United Kingdom which is also a highly industrialised country, research is somewhat differently supported. There is large Government expenditure on research in relation to aircraft and on the development of atomic energy and there is direct Government expenditure on defence research. The total appearing in the Civil estimates (1953-54) under the heading "Research and Development" is £216 million. Research expenditure on agriculture, medicine and industry, is mainly controlled through advice provided by the Medical Research Council, the Advisory Council of the Department of Scientific and Industrial Research and the Agricultural Research Council which are all under the Lord President of Council. The Treasury provides a grant not included in the above total to the autonomous universities through the University Grants Committee amounting to some £30 million per annum, only part of which is spent on teaching and advancement of research in the sciences. Special grants on quite a small scale (which are administered by the Royal Society) are made for assisting scientific research work, for provision of equipment and for publications.

Under the grant to the Department of Scientific and Industrial Research which in 1953-54 was £5·7 million, the Department administers the government research establishments (National Physical Laboratory, Building Research, Fuel Research, Food Research, Forest Products Research, Fire Research, Geological Survey, Hydraulics Research, Mechanical Engineering Research, Pest Infestation, Radio Research, Road Research, Water Pollution Research and Chemical Research Laboratories). It also provides grants of about £1·3 million to 42 Industrial Research Associations covering many manufacturing industries to which industry contributes nearly two-thirds of the total expenditure of about £4 million. Grants for training young research graduates (£250,000) and grants for special researches in universities and elsewhere (£300,000) were also provided.

The expenditure on research under the grant to the Agricultural Research Council is about £1 million but there are further amounts of about £4 million on other agricultural, forestry and fishery research

grants. The expenditure towards the work of the Medical Research Council was about £1·8 million in 1953-54 estimates, but there are many other medical research items. Good deal of medical research is done in the government teaching hospitals and in the universities.

There are also quite a number of fellowships and scholarships provided from private benefactions. According to a survey made by the Federation of British Industries in 1947, the total annual expenditure by British industry on research and development within its own establishments is of the order of £30 million which represents about 0·7 per cent. of the total annual value of British manufacture.

These figures which may not be exact are perhaps enough to indicate the extent of research expenditure in U.S.A. and U.K. and give an indication of the ways in which scientific research is supported in countries which have long been industrialised. India's problem is very different. It has been decided that a rapid industrial expansion is required in order to employ an increasing population and to raise the standard of living of the whole nation. Expansion of industry could be effective in the present state of world trade only if it were made so that industry was modernised. It was, therefore, essential that there should be an efficient organisation for scientific research on which industry could draw to help it in its efforts to modernise. It was decided to establish government research institutes directly for this purpose. As most of the industries were not highly developed or numerous, it would not have been practicable to form Research Associations on the U.K. pattern [Section IV (g)]. It was essential to provide the industries with general laboratories, serving large sections of industry and with laboratories to aid certain specialised growing industries. The laboratories are needed if only to develop the natural resources of India and to set the standards of quality of the goods produced.

The laboratories which have already been established and are in action, are:

1. The National Physical Laboratory
2. The National Chemical Laboratory
3. The National Metallurgical Laboratory
4. The Fuel Research Institute
5. The Central Glass and Ceramic Research Institute
6. The Central Food Technological Research Institute
7. The Central Drug Research Institute
8. The Central Road Research Institute
9. The Central Electro-Chemical Research Institute
10. The Central Leather Research Institute
11. The Central Building Research Institute
12. The Central Salt Research Institute

Under the circumstances, the policy in our opinion was fully justified, and the Committee have been greatly impressed at the rapidity and the efficiency with which these laboratories and institutes have been brought into action. If delayed, the cost would have not only been much enhanced, but they would have lost much of their value. For the value is that now that these laboratories are in existence, they can do much not only to help modernise the industries but also to develop natural resources. We have given thought to other ways in which industry might have derived the help of science, but we do not think that any such ways would have been as effective or as quick.

The question whether India's industry is at present large enough to require such a fine set of laboratories is easily answered. Firstly, the number of laboratories in industry is few and the new laboratories will supply a common need and secondly, they are needed to help in India's industrial expansion and will not be any too large when that expansion takes place, even though more industrial firms may by then have laboratories of their own. The National Laboratories thus will call the tune.

III

THE NATIONAL LABORATORIES AND INSTITUTES

(a) General Observations

In Table II will be found a list of the institutes, the period between laying of foundation-stone and the opening, the capital cost (to date) of the construction including services, equipment, furniture, books, etc., the recurring expenditure for 1952-53 (the latest year for which complete total figures are available), the floor space, the total number of staff (technical and non-technical), the ratio of non-technical and scientific technical staff and the number of scientific and technical staff. The table gives at a glance the main facts about the various laboratories and institutes.

It will be seen from Table II that the speed with which the laboratories have been erected and set into operation is very satisfactory.

The total donations (see Tables III & IV) received or promised towards the establishment of the National Laboratories amount to about Rs. 3.5 crores. These include land valued at Rs. 1.37 crores and Rs. 1.12 crores for building such as the Cheluvamba Mansion in Mysore (The Central Food Technological Research Institute), the Chattar Manzil Palace in Lucknow (the Central Drug Research Institute) and the building in Bhavnagar which the Central Salt Research Station occupies. The amount of cash promised is Rs. 90 lakhs and this does not include the Research Association Laboratories (about Rs. 1 crore). It may be mentioned that a sum of Rs. 7.95 lakhs being the personal share of royalties and donations was contributed by Dr. S. S. Bhatnagar till 1949 for research work at the Punjab University, Lahore, and the Laboratories of the Council of Scientific and Industrial Research. The Government contribution amounts to about 6 crores. This is not a large capital expenditure to obtain 16 large institutes and laboratories together with assets which amount to over 3.4 crores.

It is noted that the whole annual expenditure of the Council was estimated, for the year 1953-54, to be Rs. 1.82 crores of which the lump sum grant from Central Government amounts to Rs. 1.71 crores. Income from royalties, routine testing and publications amounts to Rs. 5 lakhs, which is already a substantial earning, equivalent to a reasonable return on the capital outlay.

Table II : Council of Scientific and Industrial Research

Organisation	Location	Date of Foundation stone	Date of opening	Total expenditure (Capital) upto 30-9-53 (in lakh Rs.)	Aunual recurring expenditure (1952-53) (in lakh Rs.)	Square footage of laboratory	Total number of staff	Ratio of Non-Technical to Technical staff	Name of Director	Name of the Deputy Director	Assistant Director (No.)	S. S. O. (No.)	J. S. O. (No.)	S. A. Seni r & Junior (No.)	Miscellaneous Tech. Staff
C.S.I.R. Secretariat	New Delhi	8-2-1952	9-1-1953	...	...	30,500	...	...	...	...	...	...	...	...	...
National Physical Laboratory	New Delhi	4-1-1947	21-1-1950	91·88	26·58	2,35,595	570	2:5	Dr. K. S. Krishnan D.Sc., F.R.S.	Dr. K. N. Mathur	9	16	16	70	299
National Chemical Laboratory	Poona	6-4-1947	3-1-1950	77·90	20·50	1,83,510	297	4:11	Dr. G. I. Finch, D.Sc., F.R.S.	Dr. M. Damodaran	5	13	21	51	127
National Metallurgical Laboratory	Jamshedpur	21-11-1946	26-11-1950	52·66	11·85	1,00,500	262	4:9	Mr. E. H. Bucknall, M.Sc.	Dr. B. R. Nijhawan.	3	7	14	29	125
Fuel Research Institute	Jealgora	17-11-1946	22-4-1950	32·87	12·30	57,681	486	5:19	Dr. J. W. Whitaker, Ph.D.	Dr. A. Lahiri	2	13	17	81	270
Coal Survey Stations	...	...	...	5·95	3·56	...	125	1:15	-do-	...	...	5	...	...	
Central Glass and Ceramic Research Institute	Calcutta	24-12-1945	26-8-1950	28·47	7·19	45,500	170	1:2	Dr. Atma Ram, D. Sc.	...	2	5	7	15	82
Central Food Technological Research Institute	Mysore	Building donated by Mysore Government	21-9-1950	14·81	8·81	1,75,000	215	2:5	Dr. V. Subrahmanyan, D.Sc.	...	1	9	12	43	85
Central Drug Research Institute	Lucknow	Building donated by U. P. Govt.	17-2-1951	24·16	11·80	55,000	138	1:3	Dr. B. Mukerji, D.Sc., M.B.	...	4	8	20	28	43
Central Road Research Institute	New Delhi	6-9-1950	16-7-1952	26·00	5·92	56,235	195	2:3	Dr. E. Zipkes, D.Sc. (Tech.)	...	5	...	6	15	92

Table II.—*contd.*

Organisation	Location	Date of Foundation stone	Date of opening	Total expenditure (Capital) upto 30-9-53 (in lakh Rs.)	Annual recurring expenditure (1952-53) (in lakh Rs.)	Sugare footage of laboratory	Total number of staff	Rate of Non-Technical to Technical staff	Name of Director	Name of the Deputy Director	Assistant Director (No.)	S. S. O. (No.)	J. S. O. (No.)	S. A. Senior & Junior (No.)	Miscellaneous Tech. Staff
Central Leather Research Institute	Madras	24-4-1948	15-1-1953	30·26	4·29	94,350	126	2:3	Mr. B. M. Das, M.A.	...	1	2	4	14	52
Central Electro-Chemical Research Institute	Karaikudi	25-7-1948	14-1-1953	23·10	2·67	67,800	112	3:5	Dr. B. B. Dey, D.Sc.	...	1	1	1	20	47
Central Building Research Institute	Roorkee	10-2-1951	12-4-1953	20·92	4·29	52,000	98	9:5	Dr. K. Billig, D.Sc. (Tech).	...	2	1	3	17	11
Central Salt Research Station	Bhavnagar	Building donated by Saurashtra Govt.	10-4-1954	...	...	16,100	34	9:8	Dr. Mata Prasad, D.Sc.	...	1*	...	...	5	9
Central Electronics Engineering Research Institute	Pilani	21-9-1953	...	...	...	1,40,000	18	3:2	...	...	1*	...	...	2	
Central Mechanical Engineering Research Institute	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
			TOTAL	400·3			2,993				37	80	121	390	1245

*Planning Officer.

Table III. Donation in cash paid or promised and estimated value of lands and buildings received by C.S.I.R. towards the establishment of National Laboratories

Laboratory	Donor	Cash	Land		Buildings		Total
			Details	Estimated value Rs.	Details	Estimated value Rs.	Rs.
National Physical Laboratory, New Delhi	Central Government	...	67 Acres	10,05,000	...	...	10,05,000
National Chemical Laboratory, Poona	Sir Dorabji Tata Trust	4,15,000	...	...	...	...	
	Tata Iron and Steel Co	4,16,000	...	...	...	...	
	Bombay Government	...	435 Acres for Rs. 6. lakhs.	30,00,000	...	...	38,31,000
National Metallurgical Laboratory, Jamshedpur.	Sir Ratan Tata Charities	11,70,000	...	...	...	...	
	Indian Steel and Wire Products Co.	1,00,000	...	...	...	...	
	Indian Met. Association	10,000	...	...	...	...	12,80,000
Fuel Research Institute, Jealgora	Raja of Jharia	...	150 Acres	4,50,000	...	...	4,50,000
Central Glass & Ceramic Research Institute, Calcutta.	Shri R. K. Aggarwal	2,00,000	...	...	...	...	
	Sir U. N. Brahmachari	10,000	...	...	...	...	
	U.P. Glass Works, Ltd.	10,000	...	...	...	...	
	Bengal Glass Mfg. Association	10,000	...	...	...	...	2,30,000
Central Food Technological Research Institute, Mysore.	Mysore Government	...	150 Acres	60,00,000	Cheluvamba Mansion.	65,00,000	
	Shri Mohan Singh	5,000	...	...	...	...	1,25,05,000
Central Drug Research Institute, Lucknow	U.P. Government	...	9 Acres	13,50,000	Chattar Manzil Palace.	25,00,000	38,50,000
Central Road Research Institute, Delhi	Archbishop of Delhi	...	31 Acres	5,00,000	...	...	5,00,000
Central Electro-Chemical Research Institute, Karaikudi.	Dr. Ram Alagappa Chettiar	15,00,000	300 Acres	6,00,000	...	...	21,00,000
Central Leather Research Institute, Madras	Madras Government	...	65 Acres	3,00,000	...	...	
	Leather Industry	10,00,000	...	...	...	...	13,00,000
Central Salt Research Institute, Bhavnagar	Saurashtra Government	...	...	2,00,000	...	15,00,000	17,00,000
Central Electronics Engineering Research Institute, Pilani.	Shri G. D. Birla	21,00,000 (Promised)	...	...	...	...	21,00,000
Mechanical Engineering Research Institute, Calcutta.	Shri Jalan	21,00,000 (Promised)	...	...	...	...	21,00,000
Coal Survey Stations	State Governments	...	...	3,00,000	...	7,00,000	10,00,000
	GRAND TOTAL	92,62,000		1,37,05,000		1,12,00,000	3,41,67,000

Table IV

Laboratory	Total estimates as included in the Five Year Development Plan	Cash Donation promised by Industry	Governmental contribution	Cost of Building, Lands, etc., and cash Donations given by individuals, industries & states				Remarks
				Cash	Land	Buildings	Total	
1. National Physical Laboratory . .	100·25	..	100·25	..	10·05	..	10·05	
2. National Chemical Laboratory . .	96·00	8·30	87·70	8·30	30·00	..	38·30	
3. National Metallurgical Laboratory .	70·75	12·80	57·95	12·80	..	..	12·80	
4. Fuel Research Institute . . .	66·25	..	66·25	..	4·50	..	4·50	
5. Central Glass and Ceramic Research Institute	34·35	0·60	33·75	*2·30	..	..	2·30	"Includes a donation of Rs. 2 lakhs from Shri R. K. Aggarwal".
6. Central Food Technological Research Institute	33·00	..	33·00	0·05	60·00	65·00	125·05	
7. Central Drug Research Institute . .	34·00	..	34·00	..	13·50	25·00	38·50	
8. Central Road Research Institute . .	29·65	..	29·65	..	5·00	..	5·00	
9. Central Electro-Chemical Research Institute	55·00	15·00	40·00	15·00	6·00	..	21·00	
10. Central Leather Research Institute .	35·50	10·00	25·50	10·00	3·00	..	13·00	

11. Central Building Research Institute .	21·00	..	21·00	..	..	..	..
12. Central Salt Research Institute . .	7·24	..	7·24	..	2·00	15·00	17·00
13. Central Electronics Engineering Research Institute	50·00	21·00	29·00	21·00	..	..	21·00
14. Central Mechanical Research Institute .	50·00	21·00	29·00	21·00	..	..	21·00
15. Coal Survey Stations . . .	9·00	..	9·00	..	3·00	7·00	10·00
16. Contribution to Silk and Art Silk Mills Research Association	5·00	..	5·00	..	..	..	..
TOTAL . .	696·99	88·70	608·29	90·75	137·05	112·00	339·80

NOTE.—1. All figures in lakhs of Rupees.

2. At the instance of the Council, the Ahmedabad Textile Industry's Research Association, Ahmedabad have collected Rs. 50·60 lakhs for the establishment of their Research Institute from industry.

3. At the instance of the Council, the Silk and Art Silk Mills Research Association, Bombay, have collected Rs. 43·65 lakhs for the establishment of their Research Institute from industry, excluding the Government contribution of Rs. 5 lakhs.

Statement showing the Actual Recurring Expenditure of the Council

	Administration	Publications division	Research schemes	Committees	Other heads T. R. J., F. S. S., and Scholarships	National Labs, Instts. including general planning	TOTAL
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1948-49	5,46,652	2,58,891	11,70,877	1,10,410	500	16,69,288	37,56,618
1949-50	6,33,045	2,35,042	9,56,404	1,12,894	2,671	27,19,633	46,59,689
1950-51	7,54,109	2,65,004	8,79,939	86,065	9,914	48,78,520	68,73,551
1951-52	6,65,419	3,42,461	7,93,856	1,08,281	7,075	75,10,316	94,27,408
1952-53	7,66,864	3,90,258	8,18,129	1,20,656	30,712	1,08,01,646	1,29,28,265
1953-54 (Estimate) . .	8,65,000	5,56,700	21,68,700	1,80,200	90,000	1,43,60,200	1,82,20,800
TOTAL . .	42,31,089	20,48,356	67,87,905	7,18,506	1,40,872	4,19,39,603	5,58,66,331

Besides meeting the running expenses of the National Laboratories, the Council expenditure includes Rs. 5·2 lakhs on sponsored research, and the work of the Board of Engineering Research and about 0·85 lakhs on fellowships, scholarships and training of personnel. The year to year expenditure of the Council from 1948-53 inclusive is given in Table 5.

The expenditure by Government on research in the universities of India (including the two Higher Technological Institutes) and in other directions (Medical and Agricultural Research, etc.), is not of such great amount that the Central Government need fear in any way that the total expenditure on research is too high. The expenditure by industry is clearly quite small in comparison with that of industrially developed countries (see Section II of this report) and more total expenditure on research rather than less would seem to be needed, if modernisation of industry and the building up of efficient research centres are to be quickly achieved. The total expenditure on research in India in relation to the national income is very much smaller than in U.K. or U.S.S.R.

(b) Impressions on the work of the Laboratories and Institutes

The next section is an attempt to give a more or less brief account of the impressions which the Chairman of the Committee and the other members who accompanied him have gathered together as a result of the visits to the laboratories and institutes.

The visits had to be very rapid and the time which could be given was not at all related to the variety and importance of the many interesting features of the work of the laboratories which the staff of the laboratories and institutes were eager to show us.

The notes follow in the order in which the Laboratories were visited.

The National Physical Laboratory, New Delhi

The National Physical Laboratory has been very carefully designed for its purpose, elegant, well sited and supplied with sufficient land for all its likely needs in the next decade. The air-conditioned auditorium in which large meetings (holding 840) can be held, and speakers can be heard, is a wise inclusion. The spacious basements serve as storage and as places for liquid air, oxygen and helium plants, air-conditioning plant and other purposes.

There are few if any institutions of this character in the world which are so designed that the work is housed as conveniently. Most similar institutions consist of widely scattered buildings, which are consequently less easily directed.

The Laboratory is equipped to perform some testing. It is not intended to provide facilities for routine testing but for special testing involving studies of methods leading to decisions about specification of standards, etc. This, in our opinion, is right. A National Physical Laboratory should "set the standards of accuracy for the Nation" (a remark made by Lord Moulton, F.R.S., when commenting many years ago on the work of the National Physical Laboratory, Teddington, England), but it should not become an establishment for routine testing for all and sundry. The Laboratory conducts research both on the fundamental and applied aspects of science.

It is very fortunate that, at the outset, the Laboratory has been able to have a man of such scientific eminence as Sir K. S. Krishnan, F.R.S., as its first Director. It was particularly gratifying that certain lines of research of a fundamental kind were being pursued on the Director's own initiative. This is of the greatest importance for not only does such work establish the reputation of the Laboratory amongst scientific institutions of the world, but, out of such work, valuable and undreamt of applications can follow. In this connection, it may be mentioned that a recent paper on the Thermionic Constants of Metals and Semi-conductors has already excited considerable interest in industrial laboratories in other lands, while Krishnan's work concerning quadrature will have many applications in theoretical analysis; the work that he has been pursuing on the part played by polarisation fields in the interpretation of anharmonicities in the oscillation of ions in crystals is also of outstanding importance.

It is particularly suitable in relation to the Director's personal contribution to physics that in the Acoustics Division, thermosonics forms a special activity, and the work on ultrasonics under Dr. Parthasarathy seems well designed to bring the Laboratory well to the fore in this field. The more obvious application of acoustical studies seemed also to be receiving attention.

It was noted that the Director encourages original work by other members of the staff, e.g. Dr. Vaidya's work in the Optics Division. Advantage has been taken to arrange for research being undertaken by Dr. Schoenberg, F.R.S., from Cambridge in the field of low temperature physics under arrangement with UNESCO.

In these ways, the Council and the Director are being wise at the outset of the Laboratory's existence to establish its reputation in the world of science. We do not consider that the fundamental work should necessarily be limited to that which arises out of the applied work of the Laboratory. It will fructify the research work that must be done on the applied problems from industry.

It is important that a National Physical Laboratory should take

part in the general effort to extend the accuracy of measurement, particularly in the ultimate standards of length, time, mass and electrical quantities and it is noted in this connection that preliminary work on a molecular resonance clock has been started. Subsidiary standards, such as volume pressure, etc., have also to be considered. It is also important that choice of long term researches on such standards should fit in well with work going on in the national laboratories of other countries. There is much to be done for instance by a collaborative effort to measure thermal properties of gas, liquid and solid systems.

It was interesting to find progress in the direct utilisation of solar radiation. This seems to be worth while, particularly, if it can be employed to provide energy for the cooling of large buildings. Problems of air-conditioning and refrigeration are no doubt also of great importance in India and will need the attention of the Laboratory.

The Laboratory is collaborating in the work of some of the other National Laboratories (e.g. the Central Drug Research Institute on electron microscopic studies of haemaglutination; the Central Glass and Ceramic Research Institute on signal glasses, etc.). Such collaboration, which extends the use of the Laboratory's special equipment, should be encouraged.

A considerable amount of 'ad hoc' work is in hand, dealing with requests by various departments and outside industrial firms for special information, some of which require experimentation. This 'ad hoc' work is to be encouraged as often interesting lines can be developed from such problems and furthermore it widens the circle in which the Laboratory can play a useful part.

In any large laboratory, it is always a difficult matter to prevent frustrations and delays due to the necessity of some administrative control. The Director of the Laboratory has an able scientific Deputy Director and an administrative assistant and it will no doubt be possible to overcome any tendencies which tend against efficient operation of the Laboratory as industry appreciates rapid attention to their request.

We noted that the Laboratory was very well equipped with machine tools and had quite good facilities for glass blowing; in fact repair work on valves was being undertaken. The general equipment of the Laboratory is of high standard but in any such laboratory provision should be made for keeping the equipment up-to-date.

It was good to note that the Laboratory was not trying to copy all that other National Physical Laboratories and Bureaux are doing,

but to concentrate on those items which are most likely to serve India's needs.

We were informed that the National Physical Laboratory has already provided useful advice to the Government in establishing the life of underground cables and in the repairs of spent valves of All India Radio.

It is of great importance that industry should get into the habit of bringing problems and fully utilising the facilities of this Laboratory. If they do this, great benefits should accrue.

The Laboratory is required, amongst other activities, for research on standards of quality, of performance, and of practice; for the investigation of raw materials and standardisation of raw materials and finished products, and for help in framing specifications. Its officers, by visits and otherwise, should keep in touch with industry's needs on these matters.

Recommendations:

(a) Fundamental scientific work should be continued.

(b) Work relating to standards could be extended to measurements on thermal properties of gas, liquid and solid systems.

(c) Much attention should be given to the requirements of industries and the necessary applied research work.

(d) Every help should be given to the Director to facilitate administration of the Laboratory.

The Central Building Research Institute, Roorkee

In any modern state, a place in which problems relating to buildings can be studied is a necessity. There are a great number of such problems continually arising and they are often localised in character. For instance, problems of supplying heat to buildings are highly important in northern countries, but in India the removal of heat is of importance.

It is pointed out in the Five Year Plan (p. 607) that research in building techniques and materials is necessary for achieving reduction in cost and improving the quality of work and that it is necessary to standardise building components, invent new materials or synthetic substitutes, and devise new building techniques. Research is in hand on basic building materials, bricks, tiles, high tension steel, laminated timber, on use of substitutes for steel and for other traditional materials, on codes of practice and factors of safety, on standardization and mass production of building components (prefabrication, etc.).

The Institute, which has been built at Roorkee for the purposes envisaged in the Plan and for future requirements, seems to be well sited, as it is in the neighbourhood of the University of Roorkee and not very far from the Forest Research Institute at Dehra Dun. The Institute is an attractive looking and efficiently designed modern laboratory consisting of several blocks of buildings very well adapted to suit its functions. A hangar built on the Director's cantilever design provides cover for pilot schemes.

The Institute is under the direction of Dr. Billig, an engineer of great distinction in prestressed concrete technology and other branches of civil engineering.

Outstanding work has already been done on brick making, the improvement of strength of steel bars for reinforcement by twin twisting, the improvement of hollow tile arch roofs, and the development of concrete shell structures.

The Central Building Research Institute's shell house is a notable achievement, for it provides a strong structure at small cost. It would seem that such structures and other large buildings on similar principles could be introduced with advantage into building schemes and given full trial.

There are no doubt considerable difficulties in ensuring that the brick making studies will have their full effect in raising the efficiency of brick making from soils and from clays because the brick fields are widely scattered.

It is recommended that those departments responsible for building, and the use of building materials should make full use of the Research Institute's studies and collaborate in getting the results tried out and adopted as widely as possible when shown to be effective. The use of prestressed concrete is a case in point.

It is noted that a review has been made of the "Scientific Principles underlying the design and construction of buildings in tropical areas". There is much that could be done by further research in this field, which involves extension of physiological experiments as well as experiments on materials and the physical characteristics of buildings.

It was learnt that the Director had considerable difficulty in finding research men with an engineering training for some of the work of the Institute.

Recommendations:

(a) Trials of the shell house and structure developed by the Institute should be made.

(b) Government Departments responsible for buildings, should make full trial and use (when proved effective) of the Research Institute's studies

(c) Further research work on buildings in tropical areas.

The Central Road Research Institute, New Delhi

The construction of roads is a formidable problem in India. The mileage of national highways alone is 13,400 while innumerable roads make the total mileage enormous (about 250,000) and there are as yet many villages without road access.

The total provision in the Plan for road development (including the States) is over Rs. 100 crores.

It has, therefore, been essential to establish a Central Road Research Institute in which problems relating to road construction are tackled. There are also several local State road research laboratories.

Surface dressings for highways are tested in the best possible way. A test track on a national highway passes through the Central Institute's premises.

Technical aid rendered by the Institute is mostly to the Army, the Ministry of Transport and the Public Works Department. Private enterprise connected with road construction is little developed in India and only a few commercial firms and individuals have sought technical aid from the Institute.

The suitability of local stone, sand and other materials for road making, questions of soil stabilisation and of surfacing, analysis of cement, concrete, soils, etc., are matters involving constant attention and laboratory work. There are also matters relating to road safety, requiring urgent investigation, as motor traffic is on the increase.

The Central Road Research Institute consists of an attractively designed laboratory provided with a large technological block which houses the research divisions, workshop and stores. Each of the four sections of the Technological Block provides a floor space of 7,680 sq. ft. and is very well adapted for the type of work that the laboratory has to do. The Administrative Block accommodates a library, a museum, an auditorium, canteen and conference room.

The Institute is at present directed by Dr. E. Zipkes, a distinguished engineer from Switzerland who is well known in road engineering circles. He has held the appointment for four years and has contributed much to the development of the work of the Institute and its collaboration with the Ministry of Transport, the Army and Public Works Departments. Research officers from the various labo-

ratories meet and information is spread through the Indian Roads Congress as well as by the publications of the Central Institute.

Occasional symposia and colloquia should be arranged at the Institute.

This Institute has also difficulties in finding suitable engineers and attracting them to research work.

Recommendations:

(a) Continuation of the work on soil stabilisation, sampling, etc.

(b) Occasional symposia and colloquia should be arranged at the Institute.

The National Chemical Laboratory, Poona

The National Chemical Laboratory is situated at five miles from Poona City, not far from the University of Poona. It is a very fine Laboratory, excellently designed for its function. There has been plenty of land acquired (475 acres). Housing accommodation can, therefore, be provided on the site. Laboratories, library, auditorium, museum, workshops, cafeteria and accommodation for the Director, stores, offices, etc., are all included in the main building and the whole is of the utmost convenience and very well designed. There is a small out-building in which pilot plant work is being done, but further provision for pilot plant operations will be needed.

The Laboratory is very well equipped with modern apparatus for chemical and physico-chemical research.

The Director of the Laboratory is Prof. G. I. Finch, F.R.S. from the Imperial College, London, renowned for his work on surfaces studied particularly by election diffraction methods. Prof Finch, who succeeded the late Prof. McBain, F.R.S., was appointed in 1952. It was evident to us that Prof. Finch had got thoroughly to grips with the work of the Laboratory and was imbuing it with activity, while his own special research interests could be brought to bear on many of the problems and to help in their solution. At the outset, the National Chemical Laboratory had to concentrate on a number of disconnected short term projects, but it has now been possible to lay more stress on long term applied problems of greater importance and to attack them by a more fundamental approach. By this means, the scientific staff will be in a position to provide authoritative guidance on problems of general interest to the chemical and allied industries. The main object of the Laboratory is being kept in view, namely to "advance chemical science and to apply chemistry for the welfare of the people." The progress of chemical industry depends on the pool of knowledge gained from fundamental work; if the pool

dries up industry has nothing to draw upon. We agreed with the Director that at least 30 per cent. of the total effort of the Laboratory could well be directed towards fundamental research work.

The main need of the Laboratory is expansion of the pilot plant work in the Chemical Engineering Division. There is also a need for grants for research workers from other institutes to come to work in the Laboratories.

In the Biochemical Division, under Dr. Damodaran's able direction, citric acid production by fermentation was under investigation and interesting results were being obtained which throw light on the nature of the process. Bench pilot plant trials were also in hand. The extended utilisation of sugarcane bagasse is under investigation. Pectic enzymes suitable for coffee curing are being prepared by a new process and others are being used for the liberation of starch from tapioca.

Bacteria are being scanned for proteolytic enzymes for the production of proteases and hexitols (sorbitol for vitamin C synthesis) are being prepared by reducing glucose by hydrogenation under pressure.

The study of the preparation of tryptophane by pancreatic digestion of casein has led to interesting results, as has the phosphopeptone from casein. Other studies in protein chemistry are of importance, for instance, the modification of the viscosity of gelatin for use as plasma substitute in blood transfusion.

Amongst other investigations of importance may be mentioned the microbiological production of hydrogen sulphide from anaerobic digestion of sewage sludge.

The National Collection of Industrial Micro-organisms which was transferred from the Indian Institute of Science to the National Chemical Laboratory in 1951 has been extended and, during the period, over 120 institutions have been supplied with nearly 350 different cultures.

In the Chemical Engineering Division (under Dr. Bijawat) the work is divided between the economics and costing of processes, pilot plant work and fundamental studies of general processes, such as drying, mixing, etc. Various investigations were in hand amongst which may be mentioned, chlorination of sewage gas, the stability of bleaching powder, the calcination of Indian limestones, the production of gelatin, the production of nicotine sulphate from tobacco wastes, the production of dicalcium phosphate without the use of sulphuric acid, the catalytic dehydration of alcohol (using bauxite of suitable activity) for the production of ethylene, the extraction of saponins,

the production of phosphorus and super-phosphate from phosphate nodules, the regeneration of nickel catalysts used in hydrogenation of fats, the improvement of cotton linters, the preparation of titanium tetrachloride and the production of carbon black from furnace oils.

From a chemical engineer's point of view, these investigations were being conducted in a very satisfactory and thorough manner and data were being obtained so that advice could be provided on the large scale operation of these and other processes. The Division is quite well equipped for laboratory scale work, but further accommodation is needed for pilot plant work.

In the Division for Inorganic Chemistry, under Dr. Gupta, studies on the chemistry of germanium, zirconium and titanium are being made. Preparation of zirconium compounds free from hafnium, of aluminium-titanium alloys and of phosphate-free thorium and rare earth chlorides from Indian monazite are under study. Modern methods of analysis are under development.

Processes for the preparation of phosphate fertilizers from various rock phosphate sources have been investigated and some pilot plant studies in collaboration with the Chemical Engineering Division have been made. Studies are also in hand for the use of 'Bitterns' (a byproduct of the marine salt industry) to provide a means whereby ammonia may be fixed and may provide a nitrogenous fertilizer containing potash. The preparation of ammonium sulphate and phosphate from trisodium and magnesium sulphate is under trial. The chlorination of minerals (monazite), the synthetic production of cryolite, and the production of titan white (from rutile) have also been subjects for studies.

The Division of Organic Chemistry, under Dr. Shah, is investigating the constitution of the antibiotic pristimerin, the synthesis of xanthones, the constitution of saponins and of coumarins and of l-diketone from spearmint oil, and of an alkaloid, gloriosine. The isolation and investigation of various plant products are being pursued, *e.g.* neem oil (*Melia azadirachta*), *Euphorbia royleana,* kamala oil, *Tabernae montana,* palwal seed oil, *Benincasa cerifera,* etc. Substances of possible chemotherapeutic importance as anti-malarials and anti-tubercular agents are also under investigation. The possibility of manufacturing processes for isonicotinic acid from citric acid and of nicotinic acid by the oxidation of nicotine is being investigated.

A carnauba wax substitute has been obtained from waste material.

The use of various reagents (*e.g.* lithium aluminium hydride, borotrifluoride) in organic synthesis and of various microchemical

methods have been investigated. The Division organises the preparation of research chemicals for special requirements. We have mentioned only a few of the investigations. Some of these, if followed up in detail, should prove to be important.

In the Division of Physical Chemistry, under the guidance of Dr. Biswas, fundamental work on surface area measurement of particles by electron microscopy, diffraction and the McBain sorption balance; studies of colloidal solutions, studies of soap-like molecules, the crystal structure of oxamic acid, the polishing and electrodeposition of metals; the study of solid-solid reactions are subjects of investigation. Research of a more applied nature is being conducted on growth of single crystals, preparation of emulsions for photographic plates and papers and for development of radio-tracer techniques. The preparation of mica products from waste mica is being studied in a thoroughly scientific manner and is leading to an improved product.

There is also a Division for the study of Plastics and Polymers under S. L. Kapur. Co-polymerisation, chain transfer and the solution properties of polymers are being studied; also systematic study of ion-exchange resins and of the chlorination of rubber have been taken up.

The study of ion-exchange resins has led to the possibility of purification by deionisation of brackish water and also of increase in the yield of edible syrup in sugar manufacture.

The Chemical Laboratory is thus alive with work of quite a practical kind and yet quite twenty-five per cent of the efforts of the staff is directed fundamental work which forms the basis of progress into applied research.

There is collaboration with other outside bodies, such as the College of Agriculture, the Forest Research Institute, the Armed Forces Medical College, etc. About 150 enquiries on technical subjects are received from industry every month and are attended to through a branch of the laboratory organised for providing the information required. Replies to a large number of enquiries about starting industries are also given.

There is a substantial list of publications and patents to the credit of the Laboratory.

Recommendations:

(1) 25 to 30 per cent of the total effort of the Laboratory could be directed to fundamental research work.

(2) Further accommodation and grants are needed for pilot plant work.

(3) Close touch should be maintained with other research laboratories and institutes and with industries.

(4) For the present the National Chemical Laboratory should be the chief centre for research for the paint, paper, printing and other chemical industries.

THE CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE, MYSORE

This Institute is accommodated in a palatial building—the Cheluvamba Mansion—which was presented to the Council by the Government of Mysore along with 150 acres of land. The Mansion has been very well adapted at small cost for the main purposes of the Institute.

We were, however, inclined to agree with the Director (Dr. Subrahmanyan) who wishes that the projected Technological Block should be created as soon as possible so that the larger equipment, workshops and engineering section could be housed more conveniently. Much of the larger equipment is in rooms which are not well adapted for the purpose of housing food processing machinery. Funds would have to be provided for this extension but the Director pointed out that, out of 33 lakhs of rupees (capital) allocated for the quinquennium, only about half has so far been provided.

The Institute carries out investigations on the properties of known and also of unfamiliar foodstuffs and secondly, on practical problems relating to food processing and preservation, with particular reference to conditions in India. We found that a great amount of work was being carried out by a capable staff, evidently enthused by its very knowledgeable and competent Director.

There are eight divisions—Biochemistry and Nutrition (Dr. Swaminathan) Food Storage and Preservation (Dr. P. B. Mathur), Food Engineering (Mr. B. H. Krishna), Food Processing (Dr. D. S. Bhatia), Microbiology and Sanitation (Mr. D. Singh Johar), Fruit Technology (Dr. G. S. Siddappa), Quality Control (Dr. M. Srinivasan), Food Information and Statistics (Dr. G. T. Kale).

The Institute is engaged in problems of great importance in a country growing food and consuming food on so huge a scale as India. Even in U.K. (where food consumption is greater than food production), there are about 6 stations dealing with food problems under the Food Investigation Research Board of the D.S.I.R.

It would take many pages to refer to the many different products and processes which were shown to the Reviewing Committee. Some of the processes have already been adopted by industry; others are awaiting exploitation. The Director pointed out the need for further extending the work of the Institute by organising a section specially

to spread knowledge of the work of the Institute by visits to works and by mobile demonstration units. Much publicity work is being well done by the Information Section which publishes the results of researches of the Institute, but there seems good reason to supplement, in the above active way, the work of the Information Section. It is important that when a product or process has been proved to be economically promising, as little delay as possible should ensue in putting it into service and making known its advantages. Sanction should be obtained, however, from the Board of the Institute before launching a product or process and it should first be carefully put to the test.

The Institute developed a composite flour mixture, known as "Mysore Flour", consisting of a mixture of tapioca and groundnut flour which was of great use in providing famine relief. The partial replacement of rice, wheat and other grains with tapioca, which yields 3 or 4 times as much starch per acre as cereal grains, could greatly help to reduce wheat importation and to save dollars. It is stated that the Filipinos have applied these findings and have legislated that the wheat flour distributed should compulsorily contain 30 per cent of tapioca flour. The Institute has experimented on the effect of such replacement and has shown that the health of growing children does not deteriorate in consequence.

The Institute has also developed a vegetable butter milk from groundnuts as a form of protective food and this was used to feed children in distress areas.

The Institute provides a diploma course in fruit processing, technology, etc., and is equipped for this purpose. It also carries out a considerable amount of testing and examination of food products in relation to control orders, etc. 600 factories depend on the Institute for advice on standards of quality.

Other processes already released or awaiting exploitation will be referred to in the section of the report dealing with such matters.

Amongst the many other items of investigation which were brought to our notice during our visit may be mentioned:

The use of alcohol as a solvent for extraction of vegetable oils.

The production of tartaric acid from tamarind.

The development of uses for jack fruit, desiccated coconut milk, banana flour and fruit juice of various kinds.

The development of synthetic rice using tapioca and particularly the means to increase calcium content and resistance to water washing.

The study of packaging problems.

The development of milk substitutes, canned rations, multi-purpose foods.

The study of grain insecticides (methylbromide, etc.).

The development of methods of potato storage (by preheating before cold storage).

The study of optimum conditions for cold storage of various perishable food, fruits and fatty products.

The study of coffee extraction, the production of special drinks, vinegars, chutneys, etc.

The possible utilisation of products such as juice from stem of banana, or from the agave, and many other plants.

It was pointed out to us that the Information Section needed more space which could only be provided when the Technological Block became available.

Recommendations:

(a) The Technological Block required by the Institute for its larger equipment and processing machinery should be provided as soon as possible.

(b) Further support should be given to the Information Section and a mobile unit for demonstration purposes should be provided.

(c) When a product or a process has been proved to be economically promising, as little delay as possible should ensue in putting it into service and making known its advantages. Sanction should be obtained, however, from the Board of the Institute before launching a product or process and it should first be carefully put to test.

The Central Leather Research Institute, Madras

The Leather Research Institute is situated far outside the City of Madras near Guindy and next to the Alagappa Chettiar College of Technology on a site provided by the Government of Madras. It is a fine spacious building with a tannery block near-by containing the machinery pertaining to an up-to-date tannery, as well as the equipment for the simpler hand processes; technical researches can thus be carried out on a semi-commercial scale.

The Administrative Block houses the laboratories, the offices, council room, library and cafeteria, and is well designed and in accord with the general excellence of the C.S.I.R.'s modern laboratories.

The Director (Mr. B. M. Das) is a well-known leather technologist and is highly qualified for the direction of the Institute. He is ably supported by the Assistant Director, Dr. Nayudamma.

We were impressed by the range and quality of the work of the Institute; it is exerting a stimulating influence on the leather industry which is mainly centred in Madras State.

Indian vegetable tanning largely depends on imported wattle bark and mimosa extract, apart from local avaram. It is necessary to find indigenous tanstuffs and the use of karada, myrobalan, white valem and other barks has been investigated. It has been possible to match wattle-tanned leather with leather tanned by some of the extracts. Studies are being made on the constitution of tannins. Avaram extract has been separated into five main fractions. The effect of salts of various kinds on the fixation of vegetable tannins is under investigation; salts of organic acids increases the degree of tannage. The measurement of pH has made possible the substitution of mangrove bark for wattle bark. The indigenous process of tanning used by South Indian tanners has been shown to be open to great improvement, reducing the cost of tanning considerably.

Improvements in salt treatment for the curing of skins for export have been made and the trouble due to hardening has been eliminated; a suitable test for the proper treatment of skin has been devised. Processes of semi-chrome tanning and combined chrome-vegetable tanning have been studied and made adaptable to various products.

Tanning with basic aluminium salts and with zirconium salts is being developed for special types of leather.

The physical chemistry of the tanning processes is kept well to the fore in all the work of the Institute and when all the equipment needed for tests of the strength and other physical properties of the leather has arrived, further progress on such investigations will follow. Leather consists of a complex system of plastic and semi-plastic fibres with intermediate less fibrous material; the physical chemistry of the tanning process is rather obscure and the constitution of the tanning agents is also obscure, so that there is plenty of room for research on the fundamental aspects of tanning and inevitably, therefore, on the practical aspects. Although the Institute is well equiped for most of its research work, there may from time to time arise the need for techniques to be used with instruments which exist in some of the large laboratories such as the National Chemical Laboratory. The salt/acid ratio in the tanning process has been shown to be of much importance. With proper adjustment of this ratio, the time of the tanning process can be greatly reduced. We were impressed by the good progress being made using modern analytical methods—chromatography, potentiometric titration, ion-exchange, photo-micrography, etc. etc. Processes for treatment of tannery effluents have been investigated and a suitable process has been found.

A process for depilating by using proteolytic enzymes from the latex of akand leaves has been devised which enormously reduces the time required and improves the quality of the leather in comparison with the lime process which involves a further process of bating. The lime process is also under close investigation. Bacteriological studies of 'red stain' have been made and the conditions, under which such stains develop, have been determined.

Many other investigations were in hand and the processes under trial in the tannery were also exhibited to us.

A great amount of advisory work and work in connection with the development of standards and specifications is undertaken.

Tanneries are taking advantage of the Institute's machinery in finishing their products. There is no doubt that this Institute is doing a fine job of work and will have a direct effect on the development of India's leather industry, both in regard to its cottage and large scale working. It seems very well integrated with the industry which it serves.

Recommendation:

(a) Facilities should be provided for the extension of work on the physico-chemical aspects of the tanning process.

THE CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, KARAIKUDI

The Reviewing Committee met the Director of the Institute (Dr. B. B. Dey) and heard from him an account of the Institute and its work. Dr. Rm. Alagappa Chettiar, who donated 300 acres of land and Rs. 15 lakhs for the establishment of the Institute, also attended a meeting of the Reviewing Committee in Madras. The Institute is situated close to the Alagappa Chettiar Colleges of Engineering and Technology and of Arts and Sciences. The proximity of these colleges and the suitability of the site for the possible production of heavy water were given as good reasons for the choice of the site. It seems, however, rather far from a centre of chemical or metallurgical industry and we recommend that a special member of the staff be deputed to visit and keep in close touch with other research institutes, particularly the National Physical Laboratory, the National Metallurgical Laboratory and the National Chemical Laboratory and with the industries concerned.

The building is well designed and provides space for pilot plant and heavy current experimental work. The Institute has its own sub-station with transformers and switchgear.

The work of the Institute is organised under the five divisions (i) Electro-metallurgy and furnace products, (ii) Electrolytic Cells, (iii) Electro-deposition, (iv) Fundamental Electro-chemistry and (v) Research Utilization and Information.

Dr. Dey, who is an experienced electro-chemist, gave an account of the problems under study at the Institute among which may be mentioned the production of high-purity electrolytic manganese, the utilisation of low grade manganese ores for production of sodium permanganate, the preparation of electrolytic cuprous oxide from copper scrap as a basis for production of antifouling paints, production of p-aminophenol from nitrobenzene, production of salicylaldehyde, preparation of potassium chlorate and various electro-deposition and electro-polishing processes.

The Institute has received a number of enquiries from industry and information has been supplied. Advice has been provided on the setting up of plants for electrolytic caustic soda and for production of alkali and chlorine, electro-metallurgical production of iron and aluminium, production of graphite and calcium carbide, electro-production of magnesium and production of ferro-manganese, manufacture of heavy water, etc.

Discussion ensued on the need to investigate further the electrolytic production of titanium, uranium and vanadium, thorium and cerium, on the possibility of further work on the oxygen-hydrogen cell and other fuel cells and on primary and secondary cells. The need for further fundamental studies of electrode processes was pointed out.

The main requirement of the Institute is residential accommodation for staff. This is urgent, for the Institute is rather isolated. The Director expressed the wish that some members of the staff should be sent for training abroad.

Recommendations:

(a) Housing for the staff of the Institute should be arranged as early as possible.

(b) Close touch should be maintained with the work of the National Chemical and Metallurgical Laboratories and necessary staff should be provided for maintaining liaison with other institutes and concerned industries.

THE CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE, CALCUTTA

"Do it now, I am not interested in excuses for delays, get on with it" is a message by the Prime Minister exhibited in the hall of

this Institute. It seems to have inspired the Institute to 'get on', for a great amount of work has been accomplished in it since it was built; like the Leather Institute it seems well integrated with the industries it serves. This is largely due to its energetic Director, Dr. Atma Ram, and his able staff.

The Glass and Ceramic Institute is a beautiful modern laboratory in L form, comprising laboratories, library, museum and offices. There is also a technological block for processing raw materials, for furnaces and workshops.

Before giving a brief description of the work of the Institute as shown to us, it may be mentioned that Prof. W. E. S. Turner, F.R.S., a renowned expert in glass technology had spent some weeks at the Institute just before our visit and had written a glowing tribute to the work of the Institute and stated that "the work of the Institute will not only be important in the present needs of the glass industry but would also lead to the establishment of new industries and stimulate a scientific approach in the different branches of the industry with which the Institute is concerned."

The Institute's programme is designed to

(i) study methods for improving the quality of glass and ceramic products, with special reference to raw materials, standardisation, and removal of defects,

(ii) find substitutes for raw materials likely to be scarce or in short supply, and to utilise indigenous materials,

(iii) develop new products and processes for producing imported articles, and

(iv) give technical assistance to industry.

Assisting and developing glass and ceramic industries come first, but fundamental studies arising out of the researches in progress are also carried out. Dr. Atma Ram is an authority on the phase rule and other branches of physical chemistry which can be very usefully applied in many of the problems.

The Committee were very much impressed by the excellence of the work which was going on in the Institute. Glass sands are available throughout India; many of the poorer grades can be improved by washing, heat treatment and magnetic separation processes which have been developed in the Institute. Some of the sands are of such high quality that they are sought by glass makers abroad. For optical glass, titanium and iron oxides should not be present.

Similar work has been done on clay, felspar and talc resources in collaboration with the Geological Survey, the Bureau of Mines and State Geology departments.

Very useful work has been done to increase the life of 'saggars' (the holder of refractory articles in furnaces). Breakage of saggars was found to be due to the presence of free quartz. Means were devised for testing the presence of free quartz by differential thermal analysis. This work can lead to appreciable reduction in the cost of manufacture of articles as the life of saggars can be doubled.

The standardisation of bottles for various uses has received special attention.

Research has also been directed to making use of waste materials, such as mica waste; insulation bricks from waste mica, giving performance equivalent to imported vermiculite bricks, have been produced. The mica bricks have good thermal properties. Foamed glass bricks of great lightness and good thermal properties have also been prepared. A number of ingenious and useful tests helpful in glass manufacture have been devised.

A satisfactory vitreous enamel containing titanium has been evolved which avoids the use of borax. The importation of borax for enamelware can now be avoided.

There has been much study of the use of glasses coloured with copper. A red signal glass has been produced of equal quality to that from selenium which can now be replaced. This also applies to the bangle industry.

Only a fraction of the work of the Institute which we were shown has been mentioned.

Dr. Atma Ram and his keen staff are leaving no stone unturned which is likely to give early assistance to the glass and ceramic industries. The only fear seems to be that in his conscientiousness, he might not have time to fully develop his own personal contribution to research and we should recommend that he be afforded still further assistance in the day-to-day work of the Institute.

We were shown the large scale furnace work in the Technological Block, the workshops and stores and thought that there was good provision for all this work.

Recommendations:

(a) The Director should be given further assistance in the day-to-day administrative work of the Institute so as to leave time for the development of his research work.

(b) Arrangements should be made so that industries can develop such processes and products as the Institute has shown to be of national advantage.

The National Metallurgical Laboratory, Jamshedpur

This National Laboratory is another of the very fine series of buildings which have been recently erected. In square footage it comes high in the list. Its site is very suitable being alongside the largest centre of steel-making in India. The total iron and steel production of India is of the order of 1 million tons of which nearly half is produced at Jamshedpur. The total requirement of India for steel is nearly three million tons. The production of alloy steel is negligible. The assistance that can be given by a research centre for metallurgical research is obvious if the industry is to expand.

There is a large main building containing offices, conference room, research laboratories, stores, library, etc. and there is also a technological block for large scale operations, pilot plant work, refractories, furnaces and workshops.

The Laboratory is under the direction of Mr. E. H. Bucknall, distinguished for his work and wide experience in ferrous and non-ferrous metallurgy. The Deputy Director, Dr. B. R. Nijhawan, is also well known for his metallurgical researches.

The Laboratory has six main divisions dealing with general metallurgy, chemistry, ore dressing, refractories, mechanical testing and physical metallurgy. There are also sections for information and liaison and for purchasing.

There is a large number of researches in hand in the Laboratory; in course of time, the Director proposes to organise the research work in such a measure that priority of effort will be given to the most important items and that more long term fundamental work will be well related to the general work of the Laboratory acting as a background to the more immediate problems.

The technical aid given to industry falls under three heads: (i) technical enquiries which are dealt with by the information section, (ii) routine testing which is only accepted when it cannot be done by the Government Inspectorate or the routine testing laboratories, and (iii) short term investigations carried out in the several divisions; these are assessed according to the work involved. Not only metallurgical industries, but mining establishments, foundries, electro-plating and electro-metallurgical establishments seek the help of the Laboratory and good touch with the industries appears to be maintained.

The Director is in control of the Government Metallurgical Inspectorate in the neighbourhood. This and the administration of the Laboratory involve considerable office work and it would be desirable to reduce this as far as possible so that he should become more free for the direction of the experimental researches of the

Laboratory and the important work of keeping in close touch with industry.

The equipment of the Laboratory seemed to be excellent; much modern apparatus was available. In the technological block, it might be suggested that the furnace work had not quite sufficient space allotted to it and some re-arrangement seemed desirable.

Interesting and important studies on nodularisation in cast irons have been made and are continuing. An alloy of copper and magnesium introduced into cast iron causes graphite to be formed in nodules and on annealing, the cast iron has high ductility. Other alloys have been tried along with Indian pig irons, which are high in phosphorus. It may be mentioned in relation to this work that Mr. H. Morrough, Research Manager, British Cast Iron Research Association draws attention to an article in the Foundry Trade Journal on the "Structure of Graphite Spherulites" by M. N. Parthasarathi and B. R. Nijhawan from the National Metallurgical Laboratory, Jamshedpur. Mr. Morrough congratulates the authors for having given a simple geometrical explanation of the nature of the bright spot in graphite spherulites and for the excellent experiments which prove their finding.

The coating of steel sheet by aluminising has been closely studied with very useful results which should be adopted as quickly as possible. The effect of copper, cerium and other additives have also been investigated and the changes have been studied by microscopic and other metallurgical research methods. Aluminium-silicon alloys have also been closely studied. The characteristics of foundry moulding sands have been investigated; this work should be of great importance to foundries.

Amongst researches of process metallurgy may be mentioned the work on thermal beneficiation of manganese ores. It is possible to raise the percentage of manganese recovered in slag. A process has also been developed for electrolytic production of 99·5% manganese from low-grade manganese ores.

Processes of importance for the recovery of manganese in spent liquors using saw dust for reduction, for the production of titanium from titanium ores, and for the preparation of zirconium are under investigation.

The work which is being done on beneficiation of ores by flotation, magnetic and other techniques is particularly significant.

A number of investigations is in progress on refractories as related to the metallurgical industries—silicon carbide, carbon, sillimanite, and superbasic and basic refractories, and graphite refractories.

Researches are being carried out on permanent magnet alloys (containing manganese and aluminium). Physical and mechanical

tests on structural steels of various classes are in hand in relation to fatigue, strength and other properties.

There are also researches of a more fundamental kind on austenitic steels.

An interesting instrument has been designed for the quick and accurate determination of elastic constants at room and at elevated temperatures.

The Laboratory is in touch with the other institutes and with the metallurgical industries.

Colloquia and symposia have been held from time to time, at which many of the activities of the Laboratory have come under technical discussion.

Recommendations:

(1) It would be desirable to reduce as far as possible the work connected with the control of the Government Metallurgical Inspectorate and administration of the Laboratory so that the Director may become more free for the direction of the experimental researches and the important work of keeping in close touch with industry.

(2) Furnace work has not been allotted sufficient space and some re-arrangement of the Technological Block seems desirable.

The Fuel Research Institute, Jealgora

The annual coal production of India is about 35 million tons. It is mainly required for Indian railways (10 million tons) and for provision of coke for the metallurgical industries (4½ million tons); only about 1 million tons are exported. The output is thus quite large and the need for coking coals will become greater as industry expands.

A fuel research institute is essential to any country which produces fuels; problems of energy supplies are of fundamental importance in the economy.

The Fuel Research Institute which we visited at Dhanbad is one of the best laboratories for fuel research anywhere. It has been under the able direction of Dr. J. W. Whitaker who has made a very notable success of the work of the Institute in the comparatively short time that it has been in operation. It is understood that it has been agreed that Dr. Whitaker will continue to give guidance and that the post of Executive Director will be filled by his able deputy, Dr. A. Lahiri. We were impressed by the happy collaboration amongst the staff.

The Institute consists of a main block in which there is a large enough assembly room and a museum; there are also administrative offices, but most of the rooms are used as research laboratories.

Besides the main block, there is another building behind the main building for coal and coke testing work and other physical and chemical research. There are also library, information and photographic sections. Two limbs of the administrative block are under construction and these, when completed, will provide the much needed floor space for special research laboratories.

The technological block situated a little way off (200 yards) from the main block contains bays for weighing, storing, breaking, grinding and sampling coals; for coal carbonization, and for studies in washing, pneumatic conveying and fluidization. Experimental work on the Fischer-Thopsch synthesis and the hydrogenation treatment of coals and tars is housed in another bay of the technological block. The workshops, instrument repairing and engineering stores are situated in other bays. Sufficient area has been set apart for pilot plants relating to steam raising, carbonization, coal preparation, pulverised fuel, etc. Several small plants are housed in lean-to sheds around the technological block (plants for research on cleaning and washing of coal, fluidised drying of lignite, grid burners, domestic ovens, producers, and water treatment by Carbion process, etc.).

There is need for more funds (Rs. 10 lakhs per annum for the coming few years) to extend the pilot plant work of the Institute. The industries served by the Institute are various and without facilities for the trial of processes on a pilot plant scale, the introduction of new processes or improvements in existing processes can become greatly delayed or postponed permanently. It is not considered probable that processes could be developed readily by the industries as at present constituted. Even in the event of the coal industry becoming more nationalised, it would all the more be necessary for pilot plant work to be done at the Fuel Research Institute.

The Director coordinates, at the central laboratory, the work of the five Coal Survey Stations situated in different coal fields and also the work of the Hyderabad Coal Survey.

The coals of India are of particular interest and importance for the geological and petrographical study of the origin of coals so that the work of these survey laboratories is not only of economic importance to India, but to coal science generally. The Assam coals are young and may throw further light on oil and coal formation while the Jharia coals are probably redeposited drift coals which accounts for the mineral matter being so closely associated with the coal substance. Coals from different parts of the world are different in

structure and behaviour. So special problems arise as to their utilisation in the different countries in which they occur. Coal washing, breaking and carbonisation offer different problems in different districts.

The research programme, we were informed, is built up from the ideas of the Director and his staff, suggestions from outside bodies and government sources; it is placed before the F.R.I. Advisory Board for further recommendations before submission to the Central Board. The priority of the work is determined in accordance with the technical and industrial importance and urgency. Equipment, funds and personnel have to be taken into account. The projects fall into two main groups, long and short term, but the principle is to achieve certain main objectives.

During the Committee's short visit, many different aspects of the experimental work of the Institute were seen. The general impression gained was that the work was being tackled by suitable modern methods and equipment and that the research workers were keen and well acquainted with up-to-date methods in the various branches of fuel technology. An instance of this was the study on moisture in coal and its relation to the internal surface. Recent methods are being used for determination of coking power; X-ray, spectroscopic and chromatographic methods are brought to bear on the problems. Bomb calorimetry is being specially developed in the Institute. Accurate work of this kind is certain to lead to useful results, e.g. the determination of oxygen in coals.

The Institute has contributed to new methods of analysis of coals, particularly for nitrogen and phosphorus, and thereby to their international standardisation. Sampling methods are of special importance.

The work being done on the Fischer-Tropsch synthesis process and on hydrogenation seems well worth while for it seems more likely that such processes might be utilized in India than would be so in U.K., for instance, where the cost of coal is much greater. Here again special experimental work is necessary because of the different characteristics of the coal.

The briquetting and blending of coals are items on the coal research programme of very special importance. The extension of the range of coking coals by blending has particular application to the expansion of the steel industry. Suitable reduction in the ash percentage by coal washing is also of moment to industry generally. The work that the Fuel Research Institute has already done on these problems has not yet led to their full development and there will be many further problems arising as this proceeds.

Much useful work is in hand on carbonization, on coal tar products and on products of oxidation of coal, e.g. the study of the influence of nitrogen peroxide in relation to humic acid production. Mention must be made of ion exchange products from coal for water treatment. Full scale developments of this process are in hand. It is likely to be of special application in India and is worthy of priority.

Good collaboration with other Council laboratories, with universities and with industrial firms is maintained. Altogether the Fuel Research Institute is fulfilling admirably the purpose for which the C.S.I.R. set up National Laboratories and Institutes, and its influence in industry is becoming more and more appreciated.

Recommendation:

There is need for more funds (Rs. 10 lakhs per annum for the coming years) to extend the pilot plant work of the Institute.

THE CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW

This Institute is suitably established in a university centre which includes a large teaching hospital. It is situated in the beautiful and historic Chattar Manzil Palace, which has been very cleverly adapted to be in keeping with a modern laboratory without destroying the main architectural features. Recently advantage has been taken of the massiveness of the original foundations to provide a water-tight basement and to avoid the flooding which previously occurred. This precaution warrants the expense. A modern animal house in good keeping with the architecture of the palace has recently been added in a suitable position on the other side of the fine gardens. This met the needs of the Institute and was an essential addition.

The work of the Institute had the advantage of being started under the direction of Sir Edward Mellanby, F.R.S., for many years head of the Medical Research Council of Great Britain. Sir Edward only undertook the direction for a brief period. Subsequently Dr. B. Mukerji has been in charge of the Institute. Dr. Mukerji is an authority on the active principles of plant products and is developing the work of the Institute so that the main object may be achieved, viz., the systematic survey of the medicinal plant resources of India. A great variety of plant and other products have been used in the past. Some are of definite therapeutic value; some are of doubtful importance. A scientific examination of the therapeutic value of these plant products is being undertaken by the Institute. Not only will the value of these drugs be determined in relation to their purpose in curing or preventing disease in comparison with other known drugs, but also there will, in all probability, arise the development of new products with new uses which will be of advantage not only to medicine but also to industry, agriculture and forestry.

The Institute seems to us commendably unique in that this work has been undertaken as a national problem. In many countries drug research has been mainly carried out in industrial laboratories.

The main work of the Institute necessarily gives rise to many subsidiary investigations involving botany, biochemical and biophysical studies, organic chemistry, microbiology and parasitology, pharmacology, chemotherapy and experimental medicine.

The staff of the Institute seemed to us well chosen in these various subjects and showed great keenness in their work. It was regretted that it was not possible to spend longer time with the research workers and to hear more about the many interesting problems which they were investigating.

In the chemical section, a live interest in the question of the molecular bond structure and constitution of various substances in relation to their physiological and antibiotic effects, their toxicity and their effect on the constituents of viruses and on protozoa was evident.

Some important results were being obtained on extracts from *Rauwolfia* species. This plant yields many different alkaloids, one of which has been found to be responsible for the action in lowering blood pressure. Many other plants have been examined and the effects of the active principles are being determined.

Modern methods of analysis (chromatographic, etc.), absorption spectra and other techniques were in use including controlled experiments on animals by up-to-date methods in order to determine the effect of the various drugs. The equipment of the Institute appeared to us to be very satisfactory for the work in hand.

The direction of a laboratory of this kind, which involves knowledge of so many branches of science, and in which priority has to be given to the work which is most worth while, is inevitably difficult. The Director has to keep abreast of the latest work in many sciences which are advancing very rapidly. He needs, therefore, to train his deputies carefully and to give them scope, while he may need to be away from time to time at such conferences as will enable him to keep well abreast of the subjects. Another way in which the work can be assisted is by sending experienced staff abroad to pick up techniques and to get into touch with recent results.

In such a wide field, concentration on certain problems is no doubt necessary. Work scattered over too wide a field may lack the tremendous detail and cross-checking which is required to establish and follow up the discovery of a new scientific fact.

The Institute seemed to us to be in close touch with the Clinical Medicine and the Pathology Departments of the University and with

the Gandhi Memorial Hospital in Lucknow and to be collaborating with other National Laboratories, such as the National Physical Laboratory. It has also collaborated with the Mission of Lepers, Faizabad and with the Central Drugs Laboratory, Calcutta. The Institute has also answered a number of enquiries from industry relating to drug production, etc.

The Institute will be greatly helped by the close proximity of the Botanical Garden which is being resuscitated under the C.S.I.R. A collection of medicinal plants will be maintained and a herbarium established.

The biochemistry section studies processes for the preparation of various substances from plant materials, e.g. phosphatides and nucleic acid, peptones, etc. In the pharmacology section drugs isolated from plants or synthesised in the chemistry section are studied and the toxic effects examined, e.g. the study of indigenous drugs reported to be useful in combating diabetes. In the experimental section, studies in eosinophilia, antibiotics from soils, testing of activity of drugs in relation to Gram-positive and Gram-negative organisms, studies on melanophore hormones in relation to leucoderma and on lipotrophic agents, are among the shorter term projects. Longer term projects, such as preparation of new drugs against infections, against amoebiasis, etc., action of antibiotics on isolated enzymes, metabolic studies on micro-organisms, biophysics of surface action and ionic interaction caused by drugs, studies of allergy, etc., are also on the programme.

The immediate studies of the indigenous plant products have provided a number of results some of which are recorded in the C.S.I.R. Review and in various scientific publications.

The Committee formed a very favourable impression of the Institute's work.

Recommendations:

1. The Director needs to train his deputies carefully and give them scope during his absence.
2. Experienced staff should be sent abroad to pick up new techniques and get into touch with recent results.
3. Concentration on certain, but not too wide a range of problems, becomes necessary to give full effect to the work of the Institute.

The National Botanical Garden, Lucknow

In March 1953, the Governing Body of the Council of Scientific and Industrial Research approved the scheme for taking over the Sikander Bagh Gardens from the Government of Uttar Pradesh. This

is an old botanical garden established originally by the East India Company but its merit as a botanical garden had dwindled in course of time. Nevertheless it can be brought into a good state with little difficulty. On 1st May 1953, the garden became the National Botanical Garden.

Mr. K. N. Kaul, who has spent a number of years on botanical research and has the experience of having worked in the famous botanical garden at Kew near London was appointed Director.

The Garden will contain a living collection of medicinal plants (over 500 species are being grown) along with a herbarium; these will be an asset in the development of drug research at the Central Drug Research Institute, which is nearby.

The Director explained to us that botanical research will be carried out, including plant breeding, for the development of new varieties and the improvement of yield of active principles and essential oils from plants of economic and medicinal importance. Already the yield of certain varieties of medicinal plants has been increased.

Besides the herbarium, which will contain rare species of plants of economic and scientific interest, an arboretum and a museum will be maintained.

The Garden is being reshaped. Green houses and an artificial lake are under construction. Fruit groves are being improved and different graft varieties of mango, citrus and other fruits are being raised.

The Garden will provide opportunities for improvement of horticultural plants as well as those of special economic and medicinal importance. A botanical section is being organised for display of representative plants of different families for educational purposes.

Plans for the construction of a botanical laboratory, a herbarium, a library and museum are under consideration by the C.S.I.R. This Garden is an interesting addition to the scientific institutions under the C.S.I.R. as it provides wide scope for valuable research in the plant world. It will also be a source of delight to the citizens of Lucknow and its visitors.

During our visit to Calcutta, the Botanical Garden, Sibpur was visited. This is the largest and the oldest of the botanical gardens and contains a very comprehensive herbarium. It has been arranged that the latter should eventually be administered by the C.S.I.R. Botanical research can then become well served.

Recommendation:

The buildings for the herbarium, museum, etc. should be erected as soon as possible.

(c) Summary of Achievements of the National Laboratories

The following notes have been prepared for the Committee and are intended to record some of the main achievements of the Laboratories and Institutes working under the Council during the past few years. There is inevitably some repetition of statements already made in the Committee's review.

The Laboratories and Institutes are referred to in the same order as in the previous section.

National Physical Laboratory, New Delhi

Three quartz clocks have been designed and built.

Equipment has been set up for the fabrication and testing of magnetrons.

A metal detector was designed and constructed to assist in detection of smuggled gold and other precious metals.

A large number of testing machinery has been acquired and installed.

Electro-dynamic type pickups have been procured for vibration analysis.

A DC amplifier was designed for measuring static and cyclic stresses of very low frequency in machine parts and structures.

Experiments were carried out on torsional rigidity and shear stresses on non-circular sections.

Extensive experiments have been conducted on electro-plating and anodising.

New magnetic fluids and flourescent fluids for crack detection in machine parts have been developed.

A low speed atmospheric return wind tunnel has been designed and tested.

A detailed study of the average wind velocities available during different hours and during different seasons in Delhi and other parts of India was made.

An adiabatic temperature control unit for studying temperature rise in mass concrete was designed and fabricated to assist Nangal Research Laboratories in studying the heat rise in different design mixtures of concrete. A mass curing cabinet and an automatic sequence timing were also designed.

Investigations were carried out for the Government Housing Factory, Delhi for testing various sizes of panels, slabs and girders of foam concrete mixtures; several devices, such as a 100-ton column

testing frame and automatic arrangements for aceelerated weathering tests were designed and fabricated.

An oxygen plant was reconditioned and set up. Considerable experimental work was done on the utilisation of solar energy and various types of mirrors were designed and fabricated for testing their performance.

A simple design of a solar cooker was worked out; the cooker is now in commercial production.

A single cylinder caterpillar engine has been installed for complete tests on heavy duty lubricating oils.

Isotope effect in MCO bands and mechanism of production of OH bands were investigated.

A metal evaporation unit for the deposition of metals on glass and other surfaces was built.

Goniometric measurements were made on holmium and erbium sulphate crystals. A new method for the measurement of the principal refractive indices of crystals has been developed.

An ion-exchange column has been set up to avoid difficulties met with in separation of rare earth mixtures by chemical means.

Extensive studies were carried out on suitability of different colours for road signs.

Railway signal lenses were tested to B.S. specification.

A foot candle meter has been designed for a survey of street lighting in Delhi.

Several glass mercury diffusion pumps have been constructed and used for various high vacuum plants.

Several types of electronic circuits have been designed and constructed.

Work has been carried out on the development of a beta-ray spectrometer. X-ray equipment of different types has been procured and assembled.

A number of standard electric instrument have been permanently set up to facilitate industrial testing.

Equipment has been designed and constructed for the determination of gyromagnetic ratios of various atomic nuclei by the nuclear resonance method using the nuclear induction technique.

Equipment for testing of sound absorbing materials, telephones, microphones, etc., has been acquired or built.

Work has been conducted on the thermal effects of ultrasonics and the equivalence relationship between sonic and thermal energies. By measurements in a large number of organic liquids it has been shown that the ratio of sound to heat energy is constant for all liquids, the value obtained being in remarkable agreement with the value determined by the conversion of mechanical or electrical energy into heat. Study of the variation of absorption coefficient with frequency in a number of organic liquids showed that the coefficient remains approximately constant with change of frequency in non-associated polyatomic liquids, alcohols and viscous liquids, while for esters the value of the coefficient drops to one-third.

A new method for simultaneously photographing on a plate the diffraction patterns produced by two sound waves of different frequencies has been developed.

Sound velocity values have been redetermined in 48 liquids to check values and the validity of the rules suggested earlier. Studies in sound velocity in organic compounds in relation to their viscosities have yielded some interesting results.

Work on developing various carbon products from indigenous materials has been pursued. A process for the production of carbon brushes has been entrusted to a firm for development.

Work has been undertaken to treat and use indigenous graphite ores for a number of purposes.

Activated manganese dioxide has been made from indigenous ores. Help was given to a firm in improving their technique of firing of black leads for pencils. A non-destruction method to judge uniformity of production of pencils has been developed.

An apparatus has been designed to standardise the fineness of cement and to prepare standard cement samples.

Help has been given in the design and manufacture of a bone digester for use by villagers.

Study has been made of the complexing of metals with organic acids and analytical methods on the characteristics of ions have been developed.

A method for the estimation of boric acid in a nickel-plating bath, without separating nickel or complexing, has been worked out.

A modified form of periodic classification has been published.

A special container for the transport of BCG vaccine was devised.

A new method for determining the thermionic constant of metals and alloys, based on the saturation vapour pressure of the electron

gas in thermal equilibrium with the substance at different known temperatures has been developed. The method is being extended to alloys and semi-conductors.

The frequency and anharmonicities of the normal mode of oscillation of the alkali halide crystals has been studied in detail on the basis of the simple Born model. A detailed study of the principal lattice oscillations and oscillation of low frequencies has been completed and published.

A new method for the determination of the principal refractive indices of transparent single crystals has been developed.

Considerable progress has been made in developmental work for producing silver mica capacitors and high dielectric constant ceramics; pilot plants for these have been set up. Facilities are being provided regularly to the radio industry for testing of radio components.

A section for low temperature physics has been set up and a number of projects are under investigation.

CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE

It has been shown that sludge from sugar factories and tanneries mixed with sodium silicate can be used as a soil stabiliser.

Investigations on brick clays have brought out the possibilities of controlling the shrinkage in bricks and obtaining high crushing strength bricks by suitably modifying the mechanical composition of raw materials.

Preliminary trials on bricks from black cotton soils of the Bombay Deccan area show that their crushing strength does not change over a wide range of firing temperatures.

Experiments by addition of small quantities of Sindri ash to the usual composition of bricks, as a flux to prevent warping, and firing under ordinary conditions have been completed.

Preliminary trials with boiler ash from Sindri have brought out the possibilities of its use as a material for making pozzolanic cement.

Surkhi lime plasters on panels with sun dried bricks have been found successful. Cement wash is also satisfactory.

A few prototype structures to illustrate the application of corrugated concrete shells to house construction have been put up.

A light duty floor introducing a non-conventional technique for use in the shell house has been evolved.

A process to improve the strength and other qualities of reinforcing steel by twin twisting of two steel bars into one stranded unit

by a simple machine, has been developed; a saving of one-third of reinforcing steel is possible by this method.

Central Road Research Institute, Okhla, Delhi

A test track with an attached diversion to test various types of road surface dressings under actual service conditions has been laid in collaboration with the Roads Organization of the Ministry of Transport.

A comprehensive study of road signs and signals specially to standardise danger warning, regulatory and informative signs was completed.

Possibilities of adapting techniques developed at the Road Research Laboratory, Harmondsworth, London to alluvial soils of India were studied.

A wheel tester for investigating the durability and economics of various designs of bullock cart wheel axle systems has been designed and constructed.

Investigations were carried out on the cause of failure of surface of a concrete and a bitumen runway and remedies suggested.

Studies on the use of locally available laterite material for road construction in an area where no stone was available were completed.

Investigations to eliminate defects noticed in certain concrete slabs used in road construction were undertaken.

Black cotton soils in India were studied to classify them into groups with clearly defined ranges of properties.

Advice has been rendered to various organisations on concrete work.

The load bearing capacity of the ground has been determined for some public buildings in Delhi and at Chandigarh.

National Chemical Laboratory, Poona

Conditions for production of fertilisers, like dicalcium phosphate and kotka phosphate, from indigenous phosphatic rocks without the use of sulphuric acid have been studied.

Experiments on solubilization of phosphatic rocks with magnesium salts and sea bitterns have yielded a product containing about 80 per cent. of the phosphate in citrate soluble form.

Mixed nitrogen potassium fertilisers have also been prepared from sea bitterns and epsom salt. Field experiments with these are

in progress. Conditions for the preparation of ammonium sulphate from epsom salt have been determined.

Considerable work has been done on the utilization of vegetable oils, not commonly used for industrial purposes. Possibilities of using tobacco seed oil in the manufacture of paints and varnishes have been established.

Work on Kamla seed oil has shown that it can be employed as an alternative material to tung oil in the paint and varnish industry.

Substitute vegetable oils to replace coconut oil in soap manufacture have been discovered.

Methods for refining neem oil have been worked out.

A process for improved extraction of castor oil in an aqueous medium has been developed.

Effects of heating on vegetable oils and stabilization of edible fats by spices and condiments have been studied.

Processes for the manufacture of gelatine from hides and skins, citric acid, calcium gluconate (fermentation), vitamin C, oxidation and modification of sugar-cane wax to compare with carnauba wax in properties, extraction of nicotine sulphate from tobacco waste and saponin from soap-nuts have been worked out.

Work on de-ionization of cane juice is in progress.

Photographic emulsions for the production of photographic papers, films and plates have been developed.

Preparation of amino acids from oil cakes has been studied.

The use of gelatine as a plasma substitute in blood transfusion has been investigated in collaboration with Armed Forces Medical College.

A simple and rapid method for the production of carotene and protein concentrates from leafy vegetables has been worked out.

Experiments have been conducted on micro-biological production of sulphur.

Several new pyridinium salts with powerful anti-bacterial activity have been synthesised.

A pilot plant for the study of factors affecting the quality and yield of chlorinated rubber has been set up.

A bench unit for producing ethylene by the catalytic dehydration of alcohol has been designed, installed and successfully worked.

A small unit for the manufacture of high grade aluminium chloride from aluminium scrap has been assembled.

A pilot plant for the preparation of titanium tetrachloride has been installed and worked.

An extensive study, including the examination of methods for the extraction of germanium and zirconium from Indian raw materials and the development of suitable methods for their estimation in small quantities have been undertaken.

The technique of high temperature chlorination has been successfully used in preparing phosphate-free thorium and rare earth chloride mixtures.

A process for the production of nicotinic acid by the oxidation of nicotine has been worked out.

Metallic salts of polymerised fatty acids have been used as varnish resins.

Cashew shell liquid has been polymerised to give films which on baking are resistant to water, organic solvents, acids and alkali.

Investigations on several indigenous essential oils have been carried out.

Special instruments have been set up: spinning top ultra centrifuge; electron diffraction camera and electron microscope.

The infra-red spectoscope is being used to study the molecular structure of complex organic molecules and the indentification of their functional groups.

An X-ray heating camera suitable for studies of samples containing a volatile component has been constructed.

The McBain-Bakr sorption balance was fabricated for surface area measurements of powdered samples. A much higher accuracy has been attained in the determination of transferance numbers of colloidal particles.

Simple and inexpensive formulations of technical DDT have been evolved.

Gem crystals, like ruby and sapphire, have been grown in a Verneil furnace.

A radio tracer laboratory has been set up.

A systematic study of the synthesis of ion-exchange resins and membranes has been undertaken. Cation and anion exchange resins have been prepared from various materials, and work on their physico-chemical properties has been carried out. Methods of preparation of cation exchange memberanes have been standardized.

A process for water-proofing and sound-proofing straw boards has been developed.

A project on the integration of waste mica splittings has been initiated.

Work has been carried out on the development of paper honey comb laminated cores from various materials with phenolic impregnants.

Central Food Technological Research Institute, Mysore

A simple and effective method of warding off insect damage to foodstuffs stored in bags by impregnation of bags with gamma BHC piperonyl butoxide and pyrethrum piperonyl butoxide combinations has been evolved; large scale trials have yielded encouraging results.

Optimum conditions for the cold storage of a large number of vegetables and fruits have been worked out and conditions for the preservation of seasonal crops, like potatoes and Sathgudi oranges, have been investigated.

Techniques for the processing of indigenous fruits and vegetables, not so far exploited industrially, have been developed.

Curried vegetables have been canned and standardised to conform to the specifications of the Armed Forces.

A satisfactory method for the preparation of orange juice concentrates has been worked out; the work has been extended to other citrus fruits, grapes and pomegranates. Fruit powders have been prepared from mangoes, pine apples, grapes and oranges.

The Indian biscuit industry has been helped by the investigations designed to extend the shelf-life of its products.

The causes of spoilage of breakfast foods were examined and conditions for preventing spoilage were investigated; the results are being practically applied by industry.

A number of problems on coffee, including quick methods to check adulteration, effect of metallic contamination on quality, technique of brewing, utilization of husk, antioxidant properties and processing of parchment coffee, has been investigated on behalf of the Indian Coffee Board.

Methods for converting coarse and second grade articles of food into acceptable forms, such as tapioca rice and tapioca semolina, have been developed. It has been shown that up to 25 per cent of cereal grains can be replaced by tapioca products without any harmful effects.

Several non-alcoholic beverages have been evolved. A home vinegar generator for preparing high quality vinegar has been developed.

Palatable and fortified vegetable milks and curds have been prepared from groundnuts.

An easily assimilated concentrated infant and invalid food, with milk casein as the starting point, has been developed.

A rich source of polyfructosan which can be converted into fructose has been discovered in *Agave vera-cruz*, a common wild plant.

Puffed products have been made from *Amaranthus paniculatus* by heating.

A simple method for preparing industrial and edible starch from banana stems has been developed.

Conditions for the use of alcohol as a solvent for oils from seeds have been worked out.

Possibilities of modifying the parboiling process to eliminate objectionable odours have been investigated and large scale trials have been carried out.

Extensive studies on the chemistry and processing of tuber starches have been undertaken.

Physiological studies on a number of vegetables and fruits have been conducted.

Central Leather Research Institute, Madras

A number of tanning processes have been developed for the manufacture of shoe uppers, box and willow sides, high class glazed kid, picking bands, upholstery leather, foot ball covers, white leather by the basic aluminium process, black and white reptile skins and rapid tannage of sole leathers.

Modifications in the traditional South Indian process of tanning E.I. kips have been worked out.

Investigations on making good upper leather from 'dead' cow hides by chrome tanning are in progress.

The influence of salts of various organic and inorganic acids on vegetable tannage has been studied.

Basic salts of aluminium chloride and aluminium sulphate have been successfully used as mineral tanning agents. Twenty-nine synthetic tanning materials have been prepared from tar distillation products.

Combination vegetable-chrome tanning extracts and aluminium-chrome mineral tanning agents have been developed.

A solid chrome tanning material with good tanning properties has been prepared to assist the tanner in making his own chrome liquors.

Mineral oil fractions have been sulpho-chlorinated and used for making chamois leather.

Chlorination of mineral oil fractions as substitutes for fish or vegetable leather oils and sulphonation of *pongam* oil for making fat liquors have been studied.

Investigations on tanstuffs of Madras State have been undertaken. The possibilities of substituting wattle bark with locally available tanstuffs have been examined, in several cases with encouraging results. Modification of tan liquors from various tanstuffs and evaluation of vegetable tanning materials have been undertaken.

A close liaison with industry, cottage scale and large scale, has been maintained. Facilities are provided to tanners to machine and finish their leathers by modern equipment available at the Institute.

Central Electro-Chemical Research Institute, Karaikudi

During the short period of its existence, the Institute has completed several investigations, e.g., electrolytic production of manganese metal, preparation of cuprous oxide and electrolytic oxidation of glucose to calcium gluconate.

Work has been undertaken on electrolytic preparation of titanium metal, production of calcium carbide, high purity electrolytic manganese, utilisation of low grade manganese ores, electrolysis of sodium sulphate solution, preparation of high test hydrogen peroxide, electroplating of bearing surfaces, electro-deposition of tin-zinc alloys, etc.

Central Glass and Ceramic Research Institute, Calcutta

Making glass and ceramic industry research conscious has been a major achievement of the Institute. The industry has been helped with advice on the improvement of furnaces, fuel economy, standardization of raw materials and improvements in quality of finished products.

Long range investigations on availability, processing and standardization of indigenous clays and talcs have been conducted in collaboration with the Geological Survey of India. The results of

the survey of glass sands were published some years back and are being utilised by the industry.

Improvements in quality of saggers used by the pottery industry have been effected; some factories have reported that the life of the saggers has gone up to more than 18 cycles.

Investigations on glass containers have resulted in the standardization of compositions for ink bottles, containers for pharmaceutical products, and soda and distilled water bottles.

The possibilities of using naturally occurring indigenous salt cake in partial replacement of imported soda ash in certain glass compositions have been established.

Selenium has been successfully replaced in the manufacture of red glass bangles (an important cottage industry) and other red glass compositions.

Boron-free enamel compositions have been developed.

Methods for producing chemical porcelain, traffic signal lenses and glasses, ceramic colours and glazes and enamel compositions for wire-wound resistors have been worked out.

Waste sludge of acetylene factories has been utilised in making decorative sand-lime bricks.

Waste mica has been used in producing insulating bricks.

A spongy foam glass has been developed for sound and heat insulation.

Conditions for the manufacture of haematological instruments have been standardised and the manufacture of these instruments by industry is being arranged.

National Metallurgical Laboratory, Jamshedpur

Beneficiation of manganese, pyrites, wolfram and graphite ores from different localities has been studied, in several cases, in collaboration with the Geological Survey of India and the Indian Bureau of Mines.

The upgrading of uranium ores has been investigated on behalf of the Atomic Energy Commission.

Washing tests have been conducted on Noamandi soft iron ores.

Flotation of sulphur-bearing clay from Masulipatam and concentration of uranium-bearing tailings from Ghatsila have been studied.

Investigations have been conducted on the separation of cryolite from flue dust produced in aluminium reduction furnaces.

Apparatus has been designed and fabricated for studying the properties of foundry moulding sands.

Processes for thermal beneficiation of low grade manganese ores, electrolytic production of high purity manganese dioxide and production of electrolytic manganese have been developed.

A new method of manufacturing low carbon ferro-chrome by reducing chromite with ferro-silicon and aluminium with a maximum yield of 89 per cent. has been evolved.

Sillimanite refractories have been successfully produced from Travancore beach sands. The production of carbon, silicon carbide, basic, super-basic, super-duty insulation, alumino-silicate and graphite refractories is under investigation.

Techniques for electroplating on non-metallic surfaces, brass plating from non-cyanide baths and recovery of nickel from silver refinery wastes have been worked out.

A process for the electrolytic preparation of beryllium has been developed.

Impact fatigue resistance and fatigue properties of structural steels are being investigated.

A study of wear resistance of rails, wheels and tyres, is in progress.

A rapid colorimetric method of estimating beryllium in beryl has been developed.

Investigations on several problems of fundamental nature, austenitic grain size control and austenitic decomposition have been completed; work on several other problems, e.g., nodular cast iron, structure of aluminised steels, etc., is being pursued.

A study of the physical properties of aluminium-silicon alloys has been completed.

Fuel Research Institute, Jealgora

India's first national survey of coal resources, in progress at the Fuel Research Institute and its satellite Coal Survey Stations, has resulted in the publication of several informative reports.

Work on the washability of Indian coals has served to emphasise the important role coal cleaning can play in augmenting the resources of metallurgical coal. These investigations have also revealed the existence of appreciable quantities of pyrites in Nowrozabad (Rewa) coals which can be separated by washing. Sizing and washing methods have been worked out to render certain Jharia coals suitable for carbide manufacture.

It has been shown that the slurry from the Jamadoba coal washery can be treated to yield about 75% of its weight as good coal with an ash content of 15%. The possibility has been examined of recovering by washing about 20% of coal in a form suitable for coking and of utilising the middlings for power generation at the Bokaro Thermal Power Station of the Damodar Valley Corporation.

Carbonization of the cleaned product from low phosphorus coals to a high class coke, renders possible their use in ferromanganese manufacture.

The coking properties of Madhya Pradesh coals and their use in blends with other coals for making metallurgical coke have been investigated in detail.

Investigations have been conducted on South Arcot lignite, e.g., drying, briquetting, recovery of montan wax, gasification and combustion.

Causes of low tar yields and low tar acid contents have been studied and advice on improvement in yield and quality of tars has been given.

Systematic studies on desulphurization, low temperature carbonization, and hydrogenation of Assam coals have been undertaken and it has been shown that 90% of the coal can be converted to liquid fuel. A detailed scheme for a 200 ton per day plant on low temperature carbonization has been submitted to the Assam Government for consideration.

A new iron catalyst for Fischer-Tropsch synthesis has been developed and a special process for the purification of synthesis gas has been worked out.

A special ion-exchanger (Carbion) from coal has been prepared and utilised on a large scale.

A process for the extraction of bituminous coal with tar oil, which can be used for producing practically ashless coal, has been established.

Methods for the preparation of active carbons from coals and lignites have been worked out.

It has been proved that indene and coumarone type resins can be obtained from Indian coal tars.

A process for the manufacture of phthalic anhydride by oxidation of phenanthrene and anthracene oil has been worked out. High yields of phthalic anhydride have been obtained.

Advice has been given to industry on the prevention of spontaneous combustion of coal in mines and on the surface, pulverised fuels, locomotive fuels, coal dust explosions, soft coke manufacture, manufacture of electrode carbons, and numerous other problems.

Investigations have been conducted on the therapeutic values of several medicinal plants used in the indigenous systems of medicine and the pharmacology of the isolated active principles has been studied.

Attempts have been made to prepare the active principle of garlic in a concentrated form.

Several samples of polysachharides were prepared and tested on mice to stimulate the production of antigenic polysachharides.

Studies on the action of anti-histaminics on snake venom have been completed.

Dried and purified extract of the tuberous roots of *Coccinia indica* has been used in studying alloxan diabetes in rabbits; lowering of hyperglycaemia and glucosurea with general improvement of health and increase in weight have been observed.

A large number of asymmetric sulphones was synthesised to investigate their potentialities as anti-mycobacterial agents.

A survey of pulses and oil-bearing seeds has shown that pulses are good sources of phospholipids.

Ninety-nine samples of Lucknow soils were examined to isolate antibiotic producing bacteria.

It has been shown that *Myxococcus virescens* and *M. fulvus* are able to lyse typhoid, dysentery and cholera groups of organisms in non-nutrient agar plates.

A survey of 100 patients of tropical pulmonary eosinophilia revealed that the age group 21-30 is most affected.

Three oxyquinoline compounds have been tested in vitro on *Entamoeba coli.*

As a result of the examination of 1,500 samples of stools from 260 patients, it has been concluded that cases of *Entamoeba histolytica* are rare while cases of *E. coli* are of common occurrence.

Three sulphones, 16 pyrimidines and purine compounds have been tested for their antiviral activity on *B. coli* with negative results.

Biopsy studies have revealed the complete absence of melanin in leucodermic patches.

ACTH exerts a stimulating influence on the ovary and the uterus of young female rats.

ACTH causes a loss of phosphatase activity from the adrenal cortex; this is probably associated with an accelerated rate of lipid metabolism and corticosteroid release.

Prolonged stimulation with ACTH causes a loss of ascorbic acid and sudanophilia from the inner zones of the adrenal cortex of mice.

Bacterial infection stress like tuberculosis causes loss of alkaline phosphatase activity of the adrenal cortex. The response is similar to that observed in ACTH stress.

(d) Research Utilization

A list of projects reported by the laboratories to be ready for development is appended (Appendix II).

The work of the Council has contributed to the economy of the country in a number of direct and indirect ways, the indirect contributions being the most difficult to assess or evaluate. The Council's income of Rs. 2.54 lakhs by way of premia and royalties represents the direct monetary benefit from the leasing out of 55 processes to industry for commercial development.

During the war a number of processes were utilised by various authorities for defence purposes, constituting a valuable contribution to the furtherance of the war effort. Instances of these are furnished by the processes on antigas cloth and vegetable oil lubricants. Antigas cloth valued at one crore of rupees was manufactured during the war period. The formula was also made available for defence purposes to some foreign governments. Vegetable oil lubricants worth Rs. 5 crores were produced by the oil companies according to the process worked out by the Council. The Council did not derive any direct monetary benefit from these, but their indirect contributions were appreciable. Assuming a net profit of 10 per cent on the value, income and other taxes were paid to the exchequer on the profits of Rs. 60 lakhs. Besides, there were appreciable savings in shipping space, sea freight, foreign exchange, handling charges, etc. Other major advantages were providing additional employment, making available materials in short supply and utilization of indigenous substances for which there was a glut in the market at that time. In partial recognition of the work on vegetable oil lubricants, both Burmah Shell and Assam Oil Companies have instituted scholarships of the value of Rs. 2 lakhs a year.

Even where royalties were earned, valuable indirect contributions have resulted from the utilization of the work of the Council. The case of bhilawan enamels is an instance in point. The use of these enamels in the coating of millions of textile bobbins had, in the words of the President of the Bobbin Manufacturers' Association, resulted

in large savings to the textile industry, by extendng the life of bobbins made from Indian woods several fold.

In addition to augmenting India's resources of metallurgical coal, the work on coal washing has revealed a new large source of pyrites. This work has also indicated possibilities of establishing new industries like ferro-manganese and calcium carbide manufacture.

The investigations on improving the quality of glass containers have assisted in the rehabilitation of the Indian ink industry.

Researches on beneficiation of minerals have opened out new avenues for the use of indigenous raw materials.

The scheme on high purity salt has led to the improvement in quality of salt manufactured from sea water.

Work on shortenings has helped the Indian biscuit industry to improve the life of its products. Studies in the nutritive properties of vanaspati have in no small measure been responsible for dispelling the prejudice of the average Indian against its use as an article of diet.

These examples serve to illustrate some of the ways in which the work of the Council has contributed indirectly to the promotion of India's industrial and economic development. No data about the extent to which technical information published by the Council is being utilised by industry are available.

Amongst the patents and processes more recently leased out for development, may be mentioned gelatine from hides and skins, solar cooker, groundnut milk curds, pristimerin, dulcitol, carbon slabs and rods for brushes and thermo-couple ammeters. Their successful working will result in the starting of new industries.

The Ink Development Project in operation at the National Physical Laboratory represents the first attempt to study in detail the technical and economic aspects of a process by arranging experimental production before entrusting it to industry for commercial exploitation.

Work on the beneficiation of manganese ores conducted jointly by the National Metallurgical Laboratory, Jamshedpur and the Indian Bureau of Mines has shown the way to obtain high grade ore from the reject dumps which have been accumulating at the manganese mines. These dumps have been estimated to contain more than 4.5

million tons of ore valued at Rs. 45 crores. The salvaging of these ores is expected to bring the state government nearly Rs. 2·5 crores by way of royalties alone. The first heavy media separation plant has been installed by Messrs. *C. P. Manganese Ore Company* and has gone into operation last month. Its successful working will pave the way for the installation of other plants. The benefits which will accrue from such developments are obvious. This example alone is sufficient to justify all the financial expenditure on national laboratories.

The above notes indicate some of the direct benefits which have arisen from the work of the C.S.I.R. and its laboratories. The indirect benefits are very great indeed and, as already pointed out, not assessable at present but will become an accumulating benefit.

IV

OTHER ACTIVITIES OF THE COUNCIL

(a) Sponsored Research and the Work of the Research Committees

This section of our report can be brief, because the details of the Council's activities are described in the Review of the work of the Council issued by C.S.I.R. and in the Review of the work of the Board. The Board is a body advising the Governing Body of the Council. There are twenty-five Research Committees under the Board:

1. Atmospheric Research
2. Biochemical Research
3. Building Research
4. Cellulose Research
5. Chemical Research
6. Essential Oil Research
7. Fuel Research
8. Measurement of Geological Time
9. Glass & Refractories Committee
10. High Altitude Research
11. Internal Combustion Engines Research
12. Leather Research
13. Malaria Chemotherapy
14. Metals Research
15. Mining Research
16. Pharmaceuticals and Drugs Research
17. Physical Research
18. Plastics Research
19. Radio Research
20. Road Research
21. Salt Research
22. Statistics, Standards and Quality Control
23. Vanaspati Research
24. Vegetable Oils Research
25. Coal Blending and Coking Research

There have also been sub-committees constituted from time to time to deal with special problems. There is no doubt that these committees set up under the aegis of the Board have given a great impetus to scientific research throughout India and have made it possible to initiate and foster research work not only in the institutes but also in other laboratories. The Council has been able with the advice of these Committees to sponsor, by grants for equipment and scientific and technical assistants, research work in university laboratories and other colleges and institutions. Universities have in some cases been assisted by means of block grants in organising and maintaining special departments. In some cases, research work in industrial works laboratories has been supported where it seems likely

that the results might be immediately utilised. The research schemes sponsored and the publications issued are set out in Appendices II and III of the Board's Review.

There were 360 different schemes sponsored since the inception of the Committees of which 110 were current in 1952-53 at 57 centres. Grants amounting to 9 lakhs of rupees have been made. 556 publications and 126 patents stand to the credit of the committees' work. Out of the total schemes sponsored, 54 were allocated to the National Laboratories.

Sponsored research under the grants-in-aid scheme has been fruitful in the training of research personnel. Many students have obtained the Ph.D. and M.Sc. degrees by working under this scheme. We wish to emphasize the importance of grants-in-aid of this kind which will help the research work centred in universities by provision of equipment or technical assistance and the provision of maintenance allowances to graduate students for training in research. In the one case, the emphasis is on the work and aid should be direct to the scientific investigator concerned; in the other case, the emphasis is on the man, the aim being to provide him with special training and the grant should be paid through the university authority concerned.

Many institutions have been aided by the Council (see Appendix IV containing a list of scientific and research institutions in India) and amongst them we may mention some which we visited. We were fortunate in being able to pay a very short visit to the Indian Statistical Institute at Calcutta and to have the privilege of meeting Prof. P. C. Mahalanobis, F.R.S. in Delhi and to hear about the work of the Statistics, Standards and Quality Control Committee. We note the advance being made in the use of quality control methods in India and statistical studies in relation to standards of living. We were also fortunate in paying a short visit to the Tata Institute of Fundamental Research at Bombay and to be shown by Dr. H. J. Bhabha, F.R.S. the very interesting work progressing in this Institute on nuclear research, cosmic rays, etc. We were shown the plans for the new laboratories which are soon to be erected on a fine site and which have been thought out in great detail and should help to make this laboratory one of the foremost in the world in this field of theoretical and experimental physics.

We were interested also to see the Institute of Nuclear Physics at Calcutta and to hear of the work being done on the cyclotron and other equipment which have been provided by grants-in-aid from the Council.

We note the activities of the Radio Research and Atmospheric Research Committees; these committees help to focus the well known

work done by such physicists as M. N. Saha, K. S. Krishnan, K. Banerjee, S. K. Mitra, K. Srinivasan and others in these fields. It would seem a wise decision which the Council has made, viz. to erect an Electronics Research Laboratory at Pilani. The growth of modern industry can be greatly assisted thereby. We were interested to spend a short time at Bangalore and to see the Indian Institute of Science and to have a talk with the Director, Prof. M. S. Thacker. It was gratifying to the Chairman of this Committee that the Government of India through the Council had provided the funds which had been asked for in the review made in 1948, and this has enabled the expansions recommended to be made. It is important that full use should be made of the facilities for post-graduate research provided by this Institute and the Institute of Higher Technology (Kharagpur). Radio research, internal combustion engine research and other research activities under the committees of the Council are being carried out in the Indian Institute of Science at Bangalore.

Many other committees of the Council have initiated important research work; mention can be made of the work of the Salt Research Committee under the Chairmanship of Dr. Mata Prasad, who was present at one of the early meetings of the Reviewing Committee. Research has been carried out on methods of improving the quality of salt and on establishing specifications of quality; also on means of beneficiation of natural deposits of salt and on processes for the recovery and utilisation of byproducts obtained in the manufacture of salt. A salt farm and research station was established at Wadala, Bombay where experimental work has been done leading to more economical methods of producing salt of standard purity, and to methods for the recovery of byproducts from bitterns. This work proved itself economically to be well worth while and a sub-committee recommended the acceptance of the building presented by the Saurashtra Government at Bhavnagar where further scientific and technical work will be done under Dr. Mata Prasad's direction.

The following are amongst the research projects which have been largely supported by C.S.I.R. in various laboratories which are not directly within the C.S.I.R. organisation:

1. Training and Research in Statistical Quality Control under the Bombay Branch of the Indian Statistical Institute
2. Ionospheric Research: (i) University of Calcutta, Calcutta (ii) Physical Research Laboratories, Ahmedabad
3. Atmospheric Ozone & Weather at Ahmedabad, Mt. Abu and Veraval
4. Palaeobotanical Investigations on Coal and Palynology at Birbal Sahni Institute, Lucknow

5. Gas Turbine Research at Indian Institute of Science and Bengal College of Engineering
6. Section of Dyestuffs Technology, Bombay University
7. Production of Research Chemicals at a number of laboratories
8. Survey and Cultivation of drug plants in Kashmir under Col. R. N. Chopra
9. Antibiotic & Microbiological Research Centres at St. Xavier's College, Bombay
10. Coal Blending and Coking Research at Jamshedpur
11. Iron without Coking Coal (projected)
12. Leather Research at Bengal Tanning Institute

During the last financial year, the Council made a grant of Rs. 26,500 to Dr. J. C. Ray for his Indian Institute for Medical Research, Calcutta. This Institute is doing useful work in the field of nutritional biochemistry, immuno-chemistry and chemotherapy, and bacteriological and microbiological investigations.

Dr. Ray has submitted a scheme for the reorganisation of this Institute. Sections dealing with Bacteriology and Immunobiology, Parasitology, Biochemistry and Cell-Metabolism and Serology and Diagnosis are proposed to be set up. The Council is considering the plan and it is proposed to make a somewhat enhanced grant this year with the ultimate object of taking over the Institute under the Council.

(b) Engineering

A Board of Engineering Research was established in 1950 as an Advisory Body to the Council parallel to the Board of Scientific and Industrial Research.

The Board set up five committees:

Hydraulic Engineering

Electrical and Power Engineering

Mechanical Engineering

Aeronautical Engineering

Civil Engineering

Research in engineering subjects had not made much headway in India, although various engineering colleges had long been training engineers. Engineers of high standing had been provided for the many large engineering (civil, mechanical, electrical and telecommunication) undertakings, irrigation and power schemes, and more recently developments in the production of machine tools. engines and even aircraft.

The Board was established to initiate and guide research in various branches of engineering and to extend financial aid for such purpose.

With a view to stimulate research activities, the Board invites proposals from individuals and research organisations, such as those under the Central Board of Irrigation, the Central Water and Power Commission, the Railway Board, the Central Electricity Board, the Indian Institute of Technology (Kharagpur), the Indian Institute of Science (Bangalore), the Engineering Colleges at Sibpur and Jadavpur, and the Engineering University at Roorkee. Few of the colleges teaching engineering have facilities for research, but the Reviewing Committee is of opinion that the Higher Technological and post-graduate research institutes (e.g. Indian Institute of Science and some engineering colleges equipped for research work) would be highly suitable places to foster engineering research. It is in similar institutions (Massachusetts Institute of Technology and Imperial College, London) that engineering research has been particularly fruitful, and there is at the Indian Institute of Science, engineering research work in hand (e.g. on internal combustion engineering, power engineering, etc.). Research work in river and irrigation engineering is mainly carried out under the Central Board of Irrigation and Central Water and Power Commission.

There are, however, difficulties in attracting young men to spend years at research to the detriment of their engineering career so far as salary and other opportunities are concerned. The same happens, however, in other countries and many of the brighter young men are attracted to remain in the institutes where engineering research is carried out mainly because of their interest in working at the problems which bring them right to the forefront of engineering progress. This means that when they do go into industry (having of course previously had some engineering workshop and other experience in industry) they are specially qualified to solve the problems which arise and sometimes get quick promotion. It is necessary, however, that the industrial firms should be sufficiently well disposed to research and to adopting new methods to take advantage of the value of such men and give them good prospects.

The Engineering Board have sponsored schemes relating to wind power for lift irrigation and generation of power, for a water purification plant (at the Central Water and Power Station, Poona) and several other smaller projects.

The Reviewing Committee feel that there is much scope for mechanical and electrical and tele-communication engineering research to aid in the development of the industries of India and that it should not be difficult to encourage such work, for almost any problem arising in industry can be studied scientifically and can

provide an interesting subject for research if the problem is well conceived at the outset. The facilities for carrying out research in the various C.S.I.R. laboratories and institutes and in the Bangalore institute, etc. are good. The difficulty, however, may be to find the investigators with initiative, zeal and the power to carry things through who are willing to take risks about their careers.

(c) Medical, Agricultural, Forestry and other Research

Some large sections of government research do not come under the aegis of the C.S.I.R. which has the Prime Minister as its President. Medical research is under the direct responsibility of the Minister of Health and the Minister of Agriculture is responsible for agricultural and forestry research. In the U.K. all government research except that relating to the Ministry of Supply and the Defence Departments (and certain other expenditures relating to research in relation to the universities, post office, Ministry of Fuel and Power, Board of Trade, etc.) come under the Lord President of the Council with his three Councils, D.S.I.R., Agricultural Research and Medical Research.

It is gratifying that the C.S.I.R.'s representative attends meetings of the Medical Research and that vice versa the representative of medical research attends the meetings of the Governing Body of the C.S.I.R. so as to maintain the much needed liaison. The same applies to Forestry and Agriculture. So many of the problems of C.S.I.R. (e.g. food investigation, drugs research, etc.) are closely related to the health and agricultural problems and we suggest that it is very necessary not to let 'water-tight' compartments grow up as very easily happens when work is carried out under separate authority.

We had the advantage of a visit to the beautiful Forest Research Institute at Dehra Dun and were interested to see the new cellulose laboratory, the pilot plant operations for wood working, wood treatment, pulp manufacture, etc., also the fine herbarium and the forestry college and research laboratories where different projects of the forests and different diseases of plants, etc., are investigated. This well known forest research centre, we were glad to find, is in close touch with the work of the C.S.I.R. Institutes and Laboratories through Dr. Bhatnagar, the Chairman of the Advisory Board of Forest Utilization

(d) Publications

Faraday once said that the story of research could be summed up in three short statements: begin it, complete it and publish it.

An important activity of the Council is the collection and dissemination of scientific information in regard not only to research but to industrial matters generally, the publication of scientific papers and

the publication of a journal of research and development. To fulfil these functions, the Council established (in 1942) the office of the Dictionary of Economic Products of India and the Journal of Scientific and Industrial Research. The Publications Division was formed in 1951 to handle all the work relating to the publications of the Council. The editorial organisation is described in the Council's Review. The publications issued by the Division are:

(i) Wealth of India—A Dictionary of Indian Raw Materials and Industrial Products

(ii) Periodicals—Journal of Scientific and Industrial Research (monthly), Vigyan Pragati (monthly), and C.S.I.R. News

(iii) Bulletins and Monographs

(iv) National Register

So far 6 volumes of the important encyclopaedia, "The Wealth of India", out of a probable 20 volumes, have been issued. The reviews of this publication have been very complimentary. The Journal includes original papers, technical articles on raw materials and products, recent developments in applied science, abstracts, notes on patent literature, etc. The Journal is now published in two sections and the issues have been increased to 120 pages. The Editorial Committee has taken note of the findings of the Royal Society Information Conference and has adopted many of the recommendations of that Conference. The Journal reaches nearly every country in the world. The Council has done well to provide this means not only of publishing the activities under its aegis, but of providing information to a very wide number of persons likely to be interested in India and elsewhere.

C.S.I.R. News was started in 1951 and is a fortnightly bulletin carrying news of the various activities of the Council and of the Institutes and Laboratories functioning under its aegis.

The Bulletins and Monographs relate to special activities of the Research Committees.

The National Register was commenced in 1949 and will shortly be completed. It appears in 3 volumes: engineers (11,916 entries), medical personnel (8,800) and scientists and technologists (9,291).

In the Documentation Section, 441 periodicals and numerous other publications received in the library are scanned and indexed, and at present there are 62,257 cards classified and arranged according to subjects. Enquiries are dealt with and technical information supplied. All this work of the Council is thorough and highly important in the development of the Indian scientific service.

The first Reviewing Committee in their report observed that industry does not appear to be sufficiently aware of the facts of the intelligence service of the Council and the extent to which it can help them in their problems. Since that date much development has occurred and each national laboratory and institute has its information service imparting information to the relevant industries and commercial organisations. In some cases analytical and investigatory work is undertaken by the laboratories to assist industries and rules have been laid down by the Council under which such services are provided (see p. 219 of the CSIR Review).

It may be mentioned that an "Intelligence Section" in the D.S.I.R. organisation, London is now part of their headquarter's records, library and information service. The functions are:

(1) to maintain touch with current economic and sociological affairs and government policy in these fields with a view to keeping D.S.I.R. informed of needs and that the attention of government departments and especially the central economic staff is called to the implications of scientific and technical advances;

(2) to keep watch on scientific progress and to call attention to advances that may be capable of industrial application;

(3) to undertake particular scientific and technical surveys as required.

It is possible that some collaboration with the London office might be mutually advantageous. There are a number of unpublished reports which could presumably be made available.

(e) Indian National Scientific Documentation Centre

An Indian National Scientific Documentation Centre was established in 1951 under agreement with UNESCO which would provide technical assistance over a 3 year period for the organisation of the Centre. The Government of India provides 2 lakh rupees per annum. The functions are as follows:

(i) to receive and retain all scientific periodicals required in India, particularly those required by the universities, scientific research organisations and government laboratories;

(ii) to supply photo-copies and translations of articles required by laboratories or individual workers;

(iii) to meet demand for abstracts as far as possible;

(iv) to prepare an index of the journals available and the journals required for various subjects;

(v) to answer enquiries from information available in the Centre;

(vi) to be a national repository for reports of the scientific work of the nation, both published and unpublished; and

(vii) to be a channel through which the scientific work of India and the surrounding countries is made known and made available to the rest of the world.

The Centre is under the aegis of the Council and controlled administratively by the Director of the National Physical Laboratory where it is accommodated. The library of the National Physical Laboratory contains over 14,000 books and 200 periodicals with good runs. A large amount of equipment for the Centre has been received from UNESCO.

An information service, a document procurement service and a translations service are provided by the INSDOC. Orders for 2.752 articles have been received up to November 1953.

An up-to-date list of titles of scientific papers is published monthly. This service is well conceived and should be a great help to the whole Indian scientific organisation and to building up the industries of India.

(f) The National Research Development Corporation

The Reviewing Committee of the Council (1949) gave attention to the utilisation aspect of researches carried out under the Council's auspices and recommended the setting up of a National Research Development Corporation for ensuring effective utilisation and exploitation of the results of research. The proposal (endorsed by the Planning Commission) was accepted by the Government in April 1953. Funds for the Corporation were to be provided in the form of a long term loan free of interest or carrying a low interest rate. The Corporation is constituted as a State-owned private company under the Indian Companies Act. The Corporation was registered on 31st December, 1953.

The main objects of the Corporation are laid down in the Memorandum of Association and are given in Appendix III of our report along with details of action already taken by the Corporation.

The National Research Development Corporation should prove a great help in the development of processes and products arising out of the work of the national laboratories and institutes.

(g) Research Associations Aided by C.S.I.R.

(i) Ahmedabad Textile Industry's Research Association (ATIRA)

The formation of Ahmedabad Textile Industry's Research Association is a result of the policy of the Government to encourage research and the establishment of co-operative research associations. A

gesture in this direction was made by the Government of India by putting into effect in 1946-47 the decision that sums expended for research purposes would be exempted in the computation of profits for income tax and excess profits tax purposes. In pursuance of this policy the Government of India came to an agreement with the Ahmedabad Millowners' Association on terms which were *inter alia*:

(i) The Ahmedabad Millowners' Association should form their own research association for the purpose of establishing a textile technological institute;

(ii) they should contribute to the said Association Rs. 48 lakhs;

(iii) the Government of India would make a contribution of Rs. 18 lakhs.

In 1946-47 the Association deposited with the Government a sum of Rs. 48 lakhs, which included Rs. 23 lakhs saved to the mill owners in the form of exemption from income tax and super tax. The Government contribution was later raised from Rs. 18 lakhs to Rs. 19 lakhs. In addition, the Government agreed to a recurring grant of 50% of the expenses of the Institute for a period of 5 years subject to a ceiling of Rs. 1½ lakhs per annum. The recurring grant is being paid to the Association since 1949-50.

The Association was registered under the Societies Registration Act, 1860 (XXI of 1860) in 1947.

The Association had a membership of 71 mills in 1950.

There are 13 members of the Council of Administration of ATIRA, three of whom are nominees of the Government of India and three persons with technical qualifications are co-opted by the Council.

The ATIRA has been established with the object of undertaking, carrying on or helping to carry on research and other scientific work in connection with textile trade or industry and other trades or industries allied therewith or necessary thereto. The above includes:

(i) improving materials used in the textile industry and the products produced by the industry;

(ii) improving of various machinery and appliances used by the industry and developing new ones for manufacturing, testing and recording purposes;

(iii) improvement of various processes of manufacture with a view to securing efficiency and reduction of costs; and

(iv) scientific research of a medical nature with special relation to the welfare of the workers employed in the industry.

The Association has established the following four Research Divisions:

(a) Physics and Physical Chemistry Division

(b) Chemistry Division

(c) Statistics Division

(d) Psychology Division

The important problems in hand at the Research Association's laboratories include:

(a) study of homogenisation of size;

(b) use of indigenous materials for permanent finishes;

(c) effect of different factors on degree of mercerisation;

(d) fibre distribution study at various stages in spinning process;

(e) optical properties of textile materials;

(f) effect of mixing varying amounts of soft waste with raw cotton;

(g) behaviour of warp beams with different moisture contents in loomsheds with varying relative humidities;

(h) working of yarn in subsequent departments with different twist factors;

(i) effect of the life and size of ring travellers on yarn quality;

(j) relationship between winding, warping and loomshed breakages;

(k) setting up standard gauges and tensions in winding for different counts and speeds.

Although attention is focussed on research of applied nature, fundamental work is not neglected. Some of the basic research carried out at the ATIRA includes:

(a) X-ray studies;

(b) study of fatigue and creep in cotton fibres and yarns during all stages of spinning, weaving and finishing operations;

(c) molecular orientation in fibres in absence of and in presence of dyed materials studied by dichroic effect produced in polarised light.

As long term projects the study of 'Fuel control' and "Statistical quality control in chemical processing in textile industry" has also been taken up.

The Psychological Division of ATIRA has commenced the study of the problems of work loads, job evaluation, illumination and effect of corrected vision on efficiency.

ATIRA has brought out a number of technical reports on a variety of subjects. It has made a very significant contribution to the employee-employer relations in the Ahmedabad textile industry. Another contribution is the dissemination of the scientific method amongst the management and technicians of the member mills. The quality control problem has been implemented in 24 mills. By the regular publication of Classified Contents List and Textile Abstracts compiled from about 150 current journals which are received at the ATIRA, it presents to the industry the results of significant developments in the field.

The administrative control of the Ahmedabad Textile Industry's Research Association has been transferred from the Ministry of C. & I. to the Ministry of Natural Resources and Scientific Research with effect from the 1st May, 1952.

The recurring expenses of ATIRA and the amount paid by the Government during the years 1949-50, 1950-51 and 1951-52 are given in the statement at Appendix V.

(ii) South India Textile Research Association

The South India Textile Research Association is still in the formative stage.

(iii) Silk and Art Silk Mills' Research Association

In 1949 the Silk and Art Silk Mills' Association intimated to the Council of Scientific and Industrial Research its desire to form an organisation to promote research in the sphere of silk and art silk industries. After preliminary discussions, the Silk and Art Silk Mills' Research Association, Bombay was registered on the 12th January, 1950, its functions including research in weaving of silk and art silk, including rayon, and dyeing and processing of silk and rayon fabrics.

The Association has a membership of nearl 350 silk and rayon mills spread all over the country. The Managing Council consists of 21 members of the Association and 3 members nominated by the Council of Scientific and Industrial Research.

The industry had originally intended to collect a sum of Rs. 15 lakhs for the establishment of its research institute and the Council promised to help with a capital grant of Rs. 5 lakhs. Actually the Association was able to collect much more from industry, the total collections now amounting to nearly Rs. 44 lakhs.

The search for land proved a problem and it was after protracted negotiations that the Government of Bombay and the Bombay Corporation agreed to give the Association a plot of land measuring nearly 3 acres (14,126 sq. yds.) in the industrial area of Worli for the location of the research institute. Plans for the building are in hand and as a first step construction of a north-light shed is envisaged.

The Association has also acquired a plot of land in the Backbay area near the Churchgate railway station for the construction of its administrative offices, museum, etc. The foundation-stone of a multi-storeyed building was laid by Dr. S. S. Bhatnagar on 31st August, 1952 and construction has proceeded briskly.

V

GENERAL CONCLUSIONS AND TENTATIVE RECOMMENDATIONS

Having commented on each of the institutes, we now turn to certain general considerations and conclusions:

1. Buildings—In the first place we are much impressed by the quality and suitability of the buildings which have been erected to accommodate the Institutes and Laboratories. Even in those cases where conversion of existing buildings presented to the Council has been made, this has been accomplished very ingeniously and successfully. The buildings bear the stamp of a master hand and should prove to be a permanent asset to India, for they are designed in such a way as to afford real opportunities for research scientists to do good work within them.

Great trouble has evidently been taken to adopt the good features of many modern laboratories in foreign countries and incorporate them in a manner to suit conditions in India. We would suggest that when grants are made by the Council of Scientific and Industrial Research towards the building of other laboratories, the advice of the architects of the Council of Scientific and Industrial Research should be obtained.

The siting of a laboratory is important. It should be in a position not too inaccessible from the industries or other organisations with which its work is mainly concerned. It should have a nearby source (university, college, etc.) from which to draw some of its scientific and technical staff. It should be in a spot where living conditions are not too troublesome. Services such as water and electricity have to be available. Climate, habitations, conditions of gift may be such that not all these requirements can always be fully satisfied. In most cases, it may be stated that all the conditions have been met and furthermore, the laboratories have been rightly spread so that they range over many states, thereby influencing a wide area.

The possession of such a fine set of institutes merits adequate funds to be set aside for their maintenance in thorough good order. It is noted that provision is being made for such maintenance, but it should be made thoroughly adequate.

2. Equipment—We have found the laboratories to be very well equipped and Dr. S. S. Bhatnagar, the Director of Scientific and Industrial Research, along with the Directors of the Institutes has

evidently been to much trouble to acquire suitable up-to-date equipment. Each laboratory should have sufficient free funds available to be used at the discretion of the Director to keep its equipment up-to-date by such additions as from time to time may become necessary. It is sometimes desirable, for the attack of special problems which may arise, to be able to obtain such apparatus with the least possible delay.

Large expensive equipment, however, should not come in this category. Such expenditure should be considered by the Advisory Board, as the expenditure should be related to the priority of other claims for large expenditure.

We note it is the general rule in the laboratories to have special arrangements for the construction and also for repair of instruments in the workshops of the institutes. This is a very desirable provision. It is also satisfactory that in several of the laboratories arrangements have been made for glass blowing facilities and for supply of liquid air. Supplies of liquid air and solid carbon dioxide are needed now-a-days in most laboratories.

3. Directors—The most important factor in the success of research laboratories is the quality of the staff. The Director has a particularly important role. In this particular organisation, in which a number of government-owned laboratories are designed to set the standards of scientific and technical research throughout India, they have a very special responsibility.

We consider that the choice of the Directors has been happy and that the Council is well served by them.

A Director should be a man of standing and experience in his own branch of science or technology with research of importance to his credit; he should also have the ability to get his staff working harmoniously and to encourage initiative and a team spirit in the laboratories. It is important that he should have experience and judgment in the selection of staff. He should command the respect of those from outside with whom he has dealings. He should not be erratic in administration. He should, however, be able to delegate his authority, so far as possible, so as to leave himself free to develop his ideas and to go round and keep in close touch with the work of the laboratory. It is very important that he should have as little time as possible taken up in petty matters of administration, which can be dealt with by a personal assistant or deputy. This deputy should be a scientifically trained man who keeps in close touch with the Director and knows his intentions, his purposes and his projects, but whose object is to take the load off his chief and leave him free for essential matters and for his scientific work. A Director has to

keep himself up-to-date particularly in his own special branch of science. Otherwise he will in course of time find it difficult to infect his staff with enthusiasm to provide suitable guidance and to be fruitful in ideas. When a Director fulfilling the qualifications cannot easily be found in India, it will sometimes be necessary to consider applications from outside. It is then necessary to adjust the emoluments so as to be in tune with conditions abroad. The fact that an applicant is risking his career in his own country must also be considered, for it is important that only foreign scientists of high distinction should be accepted for appointment by the Council.

4. Running Expenses—We recommend that the Directors should be given as much autonomy as possible and as much freedom as possible in the handling of funds placed at their disposal for the running of the work but not the expenditure involving capital outlay. A considerable degree of decentralisation would seem to be advisable. Once his programme has been approved by the Board and the Governing Body of the Council, he should be given authority to proceed with the work within the funds granted for the various projects. There should be a margin of adjustment (say 10%) which the Director could use at his own discretion, so that he has some latitude for the running of the laboratory without having to refer to the central office which must always give rise to some delay. This is most important for the running of any research laboratory, for there are always small requirements which in the nature of things cannot be foreseen. A saving on one fund might reasonably be used to help expenditure on another fund, if the Advisory Committee agrees; priorities sometimes change.

5. Advisory Boards of Institutes—We note that each Laboratory and Institute has a small Advisory Board. This Board meets from time to time at the Institute and the Director can thus feel that he has an authoritative body of responsible advice behind him in his own special sphere of work. The Chairman of the Board would be appointed by the Council and should, of course, not be the Director of the Institute. The Board responsible for the Institute should be separate from the special Research Committee. In order to meet the criticism that there is not sufficient co-ordination and technical guidance of research at the centre in respect of the work of the laboratories, it is suggested that there should be at least one member of each of these Committees on the central board to whom the officers at the centre could refer on special matters connected with the laboratories and institutes, which being matters of general policy could not be dealt with by the Director concerned. This, it is thought, might help toward focussing objectives and preventing dispersion of scientific effort.

6. Committees and Boards—In general, on the Boards and Research Committees of the Council, as far as possible appointments should be for a set period with retirement in rotation. Re-election after a short period, for instance, one year, should be permissible. The Chairmen of Boards and Committees should be chosen by the Council, scientific representation being particularly important. There is an approximate 3:2 predominance of scientific advice at present and this would seem to us about right. Scientific and technical predominance must be maintained as it is necessary to have a wide range of advice. The Council has been particularly fortunate in the receipt of gifts. In order to maintain a right balance of representation on the Council, it would seem desirable that donors as a group should have the right to nominate one representative on the Council, although some donors may be selected for other reasons.

The number of Research Committees of which there are at present 25 should be kept within bounds and should be terminated when their work is not urgent enough to warrant at least two or three meetings a year.

The central executive should leave as much detailed administration as possible in the hands of the various institutes, acting in a co-ordinating and guiding capacity. The Council should maintain close relation with other Departments of State (Education, Health, Works, Agriculture, Food, etc.) and other scientific and technical organisations (e.g. scientific societies) so that the scientific organisation can be an organic whole.

It is important that the Government representatives for medical research, agricultural and forestry research should attend such meetings of Committees of the Council as would be helped by their presence or as would help their work. Other Departments could be represented by assessors or observer members at Committees of the Council of Scientific and Industrial Research when the subjects under discussion warrant their presence and vice versa. There is much that can be done to make known the work of the Institutes and to encourage the work by the organisation of symposia, etc. We know that all this has been very actively pursued under Dr. Bhatnagar's leadership, but his good work should be encouraged to prosper. The relationship of the Council of Scientific and Industrial Research organisation with the universities is of great importance to maintain the quality of the supply of scientific staff to the Council's establishments and also to encourage centres of research in the universities. One great benefit of the C.S.I.R. Laboratories is that it opens out opportunities for the abilities of youth. It should become easier thereby to bring out exceptional ability and to employ it somewhat earlier in responsible posts and on committees of the organisation than has been the tendency in the past.

7. Staff of Laboratories—The staff of the Laboratories have been well chosen, it seems from our brief inspection, and as far as we could judge, there was a good team spirit in the various Laboratories and we met many bright and keen young research workers. It is fortunate that the C.S.I.R. is an autonomous body so that choice of staff and conditions under which work is carried out are the Council's responsibility. The scales of pay also seem to us to be satisfactory except that there may need to be some latitude for higher starting salaries in special cases and that it seems necessary to provide ways and means to attract certain categories of research workers, e.g., those with engineering or medical training. We recommend that consideration be given to this [see Section IV (b)]. It is very important in laboratories with a set establishment that there should be a continual revivification taking place. In many universities this occurs naturally; young men of distinction as they graduate, come to research and if they show special promise, are found places on the staff or move out to posts as lecturers at other universities. There is a continual flow and refreshment, bringing with it the fructifying ideas of the young mind, centred round the professors or leaders of research. That is a very desirable state of affairs in which research should flourish. University research is centred round the chair; if the professor changes, the special branch of subject also changes.

It is less easy to provide for flexibility in an establishment. An establishment—a National Laboratory or Research Institute—is organised round the subject. The Director has to be a specialist and the staff have to be experts in the subject with which the institute deals. If, however, the Director wisely does not always fill up quite all the posts available for his full complement of staff and if he is in close touch with industry, universities and other bodies so that he can recommend research men for jobs elsewhere when suitable circumstances arise, then a flow can be maintained and incentives for fairly rapid promotion can be provided. Promotion should take into account capacity and application. The establishment cannot well afford to lose its experienced men, and it cannot retain them unless a certain security of tenure can be provided.

Fortnightly colloquia amongst the staff and occasional symposia are being held in many of the laboratories and these are excellent ways of keeping up the interest of the staff in their work.

It is also suggested that thought should be given to incentive towards exceptionally good work by a prize or special award given from time to time.

It is noticed that some of these suggestions are already in operation in some of the laboratories but it is thought worth while

to refer to them, as prevention of any stereotyping of work in the laboratories is important.

8. Relation with Universities—It might also perhaps be suggested that some members of the staff of the laboratories should have opportunity to undertake some teaching of their subject at post-graduate level in neighbouring universities, etc. and that the universities should in turn send some graduates with special aptitude for research to work in the well equipped national institutes. It is understood that arrangements have been made between certain universities and national laboratories that post-graduates in special cases can carry out their research work in the laboratories and obtain thereon a Ph.D. degree. Some post-graduate studentship grants should be available for the university to award for this purpose and perhaps one or two studentships might also be available for offer by each of the laboratories and institutes.

It is understood that arrangements have been made for the appointment of a separate executive officer at headquarters, CSIR, (a liaison officer) to ensure that as far as possible the university laboratories, laboratories of higher technological colleges and the Government laboratories fit into a scheme wherein they are operating in mutual support. He would keep in close touch by visits or otherwise with the Directors of the laboratories and with other institutions and university departments aided by the Council. The above bodies should form an interdependent scientific organisation. Much depends on the 'healthy' state of the universities. It is necessary for a regular and balanced supply of thoroughly well educated young research men who are not only well trained in their subjects but have character and initiative, from which to fill posts in the national laboratories. It is also needed to supply the future scientifically and technically trained personnel for industry, public works and engineering of many kinds. To this extent we are concerned with the state of health of the universities but we should also like to make the following further comments.

It is satisfactory to note that a University Grants Commission has been set up to provide grants to universities so that an adequate staff of suitable high standard can be maintained by improvement of salary scales. Encouragement should be given to research at the universities and higher technological institutes. An active teaching centre, particularly in the sciences, can best thrive where the professors and staff are able to pursue the particular fundamental investigation which interests them. We are glad to note that university professors receive assistance—grants for equipment and for research assistants—from the Council in connection with schemes which the Council's Committees allocate to universities' departments. Extension of such schemes to assist post-graduate work would in our opinion be advisable.

9. Technical Staff—We noted with satisfaction that the workshop staff of the laboratories seemed to be efficient. Much of the success of a laboratory depends on the work of the technical operatives. Everything should be done to engage their interest and provide incentives for them to improve their skill and training and to work closely with the scientifically trained staff. The scientific staff, on the other hand, should not lean on their help too much but do things for themselves. The criticism has been made that in industry technical management (foremen, shop managers, etc.) is not always so highly trained as in some countries but such lack as there may have been is being rapidly corrected by various technical courses.

10. Factory Management—It is understood that arrangements have been made for instruction in business and factory management. We should like to suggest that in such instruction the importance of research should be impressed on all who take such courses and that the purpose of the national institutes should be made clear to the students who take courses of instruction in factory management.

11. Fundamental or Applied Research—There is much misconception about terms such as 'fundamental' or 'applied' research. Research is searching for order in Nature by analysis or carefully designed experiment. More often than not the results of so called fundamental research—research undertaken simply to gain further knowledge—lead to new applications. Most of the big new developments has come unexpectedly that way. "The human mind is absurd in what it seeks but great in what it finds" (Paul Valery). To illustrate the importance attaching to fundamental research, the President of the Council of Administration of the great firm of du Pont de Nemours, U.S.A. stated in his survey for 1952, "We spend yearly 2·8% of our gross income on scientific research; we take out one patent daily and we believe that by 1970, 60% of our gross income will come from products which are at present totally unknown or on which research has hardly begun today".

Improvement of existing processes or products, however, can come about by persistent detailed applied research. For instance, the aero piston engine took years of development to get it to the pitch of efficiency to which it attained. Fundamental and applied research best go hand in hand. Technical problems often need to be tackled in a fundamental way and, on the other hand, fundamental problems often arise for solution in the course of tackling a technical problem. It is wise not to tie the research programme of an institute too completely to purely practical problems but to encourage fundamental research work being done along with the researches of more immediate direct application. An institute needs to answer enquiries and to carry out a certain amount of ad hoc experimental work, but

this should not be allowed to take up too large a fraction of the institute's total effort, for, although it may be useful for the short term needs of industry, such work is of less ultimate value and should diminish as the industries become more efficient in technical ways. A certain amount of repetition and trial of existing and well known processes (or products) is necessary partly to adapt the processes to conditions as occur in India and partly in training staff to become acquainted with them. It was noticed that some of the work of the institutes was of this kind.

When an institute has established its position in the world in any branch of its work—which may indeed be quite restricted—whereby it becomes the forefront of the scientific advance in that particular subject, then indeed its reputation is made and it will find that investigators from other countries will be wanting to come to work in it or to consult it. We think that some of the institutes are well on the way to reach this happy position, and it should be the aim of all, from the Director down through the staff, to attain this excellence.

12. Research Programmes—The method of planning the work of the institutes will tend to vary with the particular institute. The National Physical Laboratory has to apply physics over a wide range of activities. The Central Leather Research Institute, on the other hand, has a more restricted field of application but many different branches of science have to be employed to tackle the problems.

Sometimes, it will be wise to organise the work on a system of objectives with a range of priorities, putting the whole of the resources of the laboratory to reach the objective or such part as the priority demands. Alternatively, it may be wise to divide the research programme into projects with a certain fraction of the funds and staff devoted to each project. The system of objectives is the one which is generally, in our view, most desirable; as it minimises the danger of the work of the laboratories becoming stereotyped and too sectionalised.

Programmes should not be allowed to get too lengthy. It is more important to have a few items actively pursued than to have the effort of the laboratories scattered over too wide a range of subjects. It is also well to remove a subject from the programme when it does not seem likely to come to fruition or when it has been finished. A certain degree of 'doggedness' is however often suddenly and unexpectedly rewarded in research work. A Director of a British Research Association describes his programming thus:

> "The first task is to select a group of researches aiming at the main objectives; the second task is to inter-relate the several

activities of the research divisions so that they mutually support each other and the third task is to publish what is found and to collaborate with technical men in industry in the interpretation of the findings and their application."

It is noticed that there is a certain amount of overlap in the work of the institutes. This should not be disparaged, provided the Directors are cognisant of the work in each other's institute; for the special equipment and methods of research in one institute can often very usefully supplement the attack on a problem in another institute. Close touch between the various institutes should, however, be maintained by encouragement of visits of Directors and of members of the scientific staff. It is important, however, to avoid doing the same thing in the same way.

Meetings of some of the Directors on matters of common interest should be arranged from time to time. A foreign expert might occasionally be invited to spend a few weeks at an institute to bring new techniques and to give his views on the work of the institute. This would be one way to ensure that the work of the institutes was being maintained up-to-date (vide Prof. W. E. S. Turner's visit).

13. Movement of Scientific Staff—Another matter to which we find that the Central Secretariat of C.S.I.R. has given much attention is that facilities are needed to permit members of scientific staff, on the recommendation of the Directors of Institutes, to visit and work in laboratories abroad or to attend certain conferences when the work of institutes can thereby be furthered.

It is important in our view that the research workers should be able to keep abreast of new techniques and developments in other countries and there should be sufficient funds set apart for this purpose in addition to such grants as may be available under the Fulbright and other schemes. The Directors should severally be consulted annually as to their likely needs in this respect. It may sometimes be desirable that the Director himself be present at a scientific conference in order to contribute to or to keep abreast of his special subject. Facilities should be provided to meet such possibilities, i.e. there should be a sufficient travel fund earmarked for such events

It is noted that a number of members of scientific staff of the various laboratories have been deputed abroad so as to become proficient in their special subjects. This information is given in detail in Appendix I.

Eventually it may be expected that the movement will not be one way, but that scientists will come from abroad to work in India's fine institutes to a greater extent than at present. It might be worth

while to supplement UNESCO and other possible sources of grants to attract a limited number of young workers from foreign countries to the laboratories.

It is reasonable that post-graduate students, still in their training period, should spend two years or three in a laboratory abroad, and return with the knowledge acquired. It is important, however, that the training which they have received should be utilised and that they should be set to work as soon as possible after their return and without loss of seniority. They should not be sent abroad without the funds needed for their journeys, maintenance and training expenses.

Apart from post-graduate student training, it would often be desirable to send more senior members of staff abroad for short periods (not exceeding six months) to pick up recent techniques, to inspect new developments or to discuss problems with the scientists abroad. An experienced research man can quickly appreciate and acquire the knowledge about a new technique in his own subject.

14. Liaison with Government Departments—The facilities for research provided by the laboratories and institutes and also the help that can be given in drawing up specifications, etc. should be continually brought to the notice of Government departmental executives. It is of course one of the main functions of the institutes and national laboratories to give help on problems submitted to them by Government departments. Special visits of officials from other departments should be arranged from time to time. It is certainly most important that over-departmentalisation should not prevent the full use of the great enterprise that has been shown by the Government in establishing the institutes. The Government departments should be first to take advantage of the processes and products developed by the institutes and should not be deterred by immediate costs from trying new methods (e.g. use of prestressed concrete). They should be ready also to place on good priority contracts for work needed for the institutes (provision of houses for staff, etc.). The work of some of the national laboratories has been held up because the housing for staff has been much delayed.

15. Implementation of Research Results—The next question to consider is whether the conditions in industry are such that the results of researches done in the institutes can be quickly developed and utilised. It is of small avail to set up a number of research institutes beautifully equipped if the results of their work cannot quickly be used.

There is actually a large gap—a difficult gap to traverse—between a process which is proved to be a success in the laboratory and its full scale operation. First the process generally needs to be operated

on a pilot plant scale so that costs can be approximately established. Then the industry has to go further into technical details and into the economics of the process and then to decide on its development before finally adopting the process on a production basis. Protection by patent or otherwise may be necessary and money is needed for setting up and running a pilot plant and still more money for developing the adjustments that have to be made before production on the full scale is achieved. It has to be ascertained from estimates of probable capital and operating costs whether it is worthwhile to develop a process to the stage of commercial production. Sometimes it is possible that no pilot plant stage is needed if no troubles are anticipated in large scale operation; sometimes, however, not only a pilot plant stage but a pre-production stage on a prototype plant has to be gone through. In the case of a machine or engine, the development stages are often very costly. Nevertheless, it is necessary at some stage or other to decide where the pilot plant trials are to take place, whether in the research laboratory or in the industrial firm. Hesitations and delays easily arise.

16. It has already been mentioned that a Research Development Corporation has been created through which these kinds of difficulties can be surmounted. The achievement of the laboratory is referred to the Corporation who arrange about the licences relating to patents taken out by the laboratories and the finding of suitable firms to undertake the development. It may often be necessary, however, before reaching that stage to prove the process by operation of a pilot plant at the national laboratory or institute. Normally such pilot plant work should not be undertaken without consultation with the Advisory Board of the institute who should provide the advice whether to submit the proposals to the Corporation or carry the process a step further by pilot plant trials.

Sufficient funds in each case must be provided either to build and operate the pilot plant at the institute concerned or to finance the project through the Corporation.

It is understood that some funds for the provision of facilities for extending the pilot plant work at the national laboratories and institutes have been granted. We have gone into the matter and as the result of our visits we recommend that the whole of the amount should be provided.

Firms could also be encouraged to make use of the national laboratories and institutes to get schemes tried out, sending, if necessary, technical staff to help in the trials, if it cannot be done by the laboratory staff. Charges should be arranged according to the nature of the work, but in order to encourage further use of the

laboratory, charges should be suitably modest. The development of a process by the national laboratories and institutes may require quite large funds but these should be largely recoverable in the price paid by the industry for the completed process.

17. Development—If economic conditions and laws are such as to make industrialists shy of the development of promising processes, then it would seem that such conditions should be modified, for it is no use encouraging research for the purpose of expanding industry, if that expansion is resisted owing to lack of incentives. It would be very undesirable that processes proved on the pilot plant scale as economically suitable for exploitation on the large scale should be prevented from being developed. This applies particularly to products which can be developed on quite a small scale. For it is through the welfare of small industries that the wheels get going, which enable the big developments to be made. Often also great industries have small beginnings. We believe that the Government are well aware of the need to provide incentives and conditions which will cause industry to adopt new processes and that initiative to get sound ventures started will be encouraged.

It is suggested that the institutes (through their Directors and Advisory Boards) being in touch with the industries which they serve should act in advising not only industrial firms but also Government departments as to the introduction of new processes and products. For instance, the industry may be prepared to adopt a new enamelware glaze which avoids the use of imported borax, but if the importation of borax is not discouraged, an indigenous but equally good substitute (made from titanium oxide) will not be adopted. This would not only be to the probable detriment of the national economy, but also waste of time and effort to the institute. Much the same state of affairs exists in regard to the use of indigenous salt cake versus imported soda ash, and of insulated bricks from waste mica chips versus vermiculite bricks imported from America or South Africa. Concerted action is needed in which the C.S.I.R. could be expected to take a lead.

Until firms employ more well qualified engineers, chemical engineers, scientists, industry will continue to work at a disadvantage as compared with firms in other countries where industrial standards are high. Industry tends to be complacent and to dislike innovations. Lack of technical enterprise is not the only cause of improvements being neglected; economic conditions may prevent the adoption of new processes by reducing the margin of profit. Immediate commercial advantage and potential national good are often at variance.

18. Liaison with Industry—Another matter to which the Institutes are attending is to discover from industrialists and their technical staff what their problems are, e.g. problems of waste disposal, of

utilisation of waste products, of small improvements in process efficiency or efficiency of manufacture, problems of purification of water or of raw materials, problems of storage, packing, etc. Opportunities for discussion of such problems should be sought and visits of staff to factories, or visits of technical factory staff to the institutes, should be frequent. We were assured that this was the happy state of affairs in regard to several of the laboratories. This liaison is particularly important because special knowledge of an industry is needed to assess properly the costs and economic value of a process. An officer versed in such matters of process costing should be attached to the National Research Development Corporation.

It is quite natural that from time to time many already well known technical processes have to be tried out in the institutes. It is necessary because the staff should become thoroughly acquainted with such processes and because modifications have to be made to suit Indian conditions and also to train operatives so that the technique of production can easily be handed over to industry.

19. Publication of Information—It is very necessary that the results of the work of the laboratories and institutes should be published and made known as widely as possible. The C.S.I.R. has been very alive to this necessity and the various steps which have been taken are referred to in the previous section. Each laboratory has its information service and some are taking great care to give as full effect to the Council's desire as possible. In a few cases, we have referred to the need for further assistance to be given for this purpose. We have also referred to the usefulness of an intelligence section at the headquarters.

20. We have received the following comments from a member of the Council of Scientific and Industrial Research:

> "While a few major industrial concerns are in a position to have their own scientific departments, a number of small-scale industries, either for lack of scientific personnel or financial resources or to plain indifference, have so far evinced little interest in industrial research. The Chambers of Commerce and other Associations of the trade and industries are mainly interested in commercial and economic matters, such as railway freight, taxes, etc. and very little is being done for the improvement of industries on the technological side. The Council have been trying to make industries interested in forming Industrial Research Associations, on the lines of the research association movement in the U.K. As a result of this, two or three Research Associations for the textile industry have been established. However, much more remains to be done in this direction. In order to fully utilise the excellent facilities available in the National Laboratories, the formation of Industrial Research

Associations on a co-operative basis is necessary. Unless the industries bring their problems to the Laboratories, either directly or through the establishment of 'Industrial Fellowships', the Laboratories will not be in a position to make important contributions to the country's industrial development. The Development Wing of the Ministry of Commerce and Industry and the Council of Scientific and Industrial Research should jointly encourage the formation of such Associations."

While agreeing with the general view that Research Associations are an excellent and economic way to provide industry with research information and facilities and to improve the technical state of an industry, we consider that until an industry is fairly well developed and has a number of constituent firms, it is difficult to work a Research Association. Until then reliance must be placed on getting the small industries interested in the work of the National Laboratories by visits and meetings arranged at the Laboratories between managers, industrial engineers, foremen and the relevant members of the staff of the Laboratories or Institutes. When the industry is ripe for the formation of a Research Association, Government support would be needed in a fairly generous measure at first.

In the well established industries, Research Associations and Development Laboratories already exist. Some of them are supported partly by industries and partly by the Council of Scientific and Industrial Research. Others have been arranged under the auspices of the Ministries of Commerce and Agriculture.

The two Research Associations formed have been referred to on page 67. Research Associations to which funds are contributed by Government might well all come under the authority of the C.S.I.R.

We are in favour of the establishment of research associations and consider that these should be developed with the help of the Council of Scientific and Industrial Research when the occasions arise.

21. General Research Themes—We consider that it is desirable that on quite broad lines the Council should be in a position to give some measure of direction to the research work done under its aegis so that it may be related to India's needs and to the general advancement of science through the work of the research laboratories. We have given some thought to this.

The conditions under which this direction could be made effective seem to us to be more or less as follows :

The ideas must mainly come from the centres of research, i.e. from the Directors of Laboratories and their Advisory Boards on which there should be some university members. These ideas thus get

incorporated into the research programmes or more likely, in a less formal way, are discussed at meetings of C.S.I.R. Research Committees at which Directors and other scientists and technical men meet.

It is at this stage that they need to be related to the Plan for India and to the general state of science and technology. That can only be done through the meeting of minds. It would seem at this stage that the Principal Executive Officer and Director of the C.S.I.R. should be in a position to call together such members of the Advisory Board, Directors and Advisory Committees of the Laboratories and others from medical or agricultural research or universities as would be needed to discuss and assess the importance and consider the priority of the particular ideas which have arisen, and to suggest suitable laboratories within the organisation or outside it where research work could be undertaken. As a result he would be in a position to present to the Advisory Board of the Council a directive in relation to the programme which is submitted to the Board for review at least twice a year and which is finally considered by the Governing Body for financial and executive action.

We believe that the present organisation operated in this way could provide the desirable guidance without being in any way a stifling influence, which it is very necessary to avoid.

In the last section we have given indication of some such broad themes along which research work might proceed.

Much of course depends on the membership of the Boards, Committees and on the officers of the C.S.I.R. We have thought it is worth setting out these views although we think matters have been quite satisfactory up to the present, for the C.S.I.R. has had the advantage of a very active officer as its present Director.

VI

SUGGESTIONS OF A SCIENTIFIC AND TECHNICAL NATURE

THE question arises whether in the opinion of the Reviewing Committee the present C.S.I.R. Laboratories and Institutes, considered along with existing institutions which come within the whole organisation for science, cover the field sufficiently well for the present or whether there should be further expansion to include other subjects or whether there should be some multiplication of existing establishments.

Our general view is that the coverage is adequate for the next few years but that certain important developments cannot be neglected. Consolidation of all that now exists is necessary.

We have learnt that it has been agreed that an Institute of Mining Research shall be provided. Dr. J. W. Whitaker has been entrusted with the work of planning this Institute. It will be situated in the neighbourhood of the Fuel Research Institute and work in close touch with that Institute. We consider this a wise addition. In England recently the Coal Board has set up a new laboratory at Isleworth for mining problems (cutting coal, mechanical and hydraulic conveyance, etc.) in addition to its laboratory for carbonisation and other problems at Cheltenham. There is also the Government Safety in Mines Laboratory at Buxton. There is certainly plenty of problems in mining which afford scope for scientific attack.

We also understand that a Central Mechanical Engineering Research Institute will be provided in Calcutta and that much of the expense is being met through the generosity of a donor. This Institute will provide opportunity for the study and development of machines and tools, gadgets and investigations, agricultural implements and devices to assist cottage industries. It would seem to us that to have such an Institute will fill a gap, for development shops such as exist in engineering firms in highly industrial countries are rather few in India.

Mechanical engineering research—the measurement of strength of materials, fatigue strength, problems of viscosity, of vibration, of heat transfer and fluid flow, etc. would best be developed in places such as the National Physical Laboratory, the laboratories of the Indian Institute of Science, Bangalore or the Higher Technological Institute (Kharagpur). We would favour the development of such work so as to attract a number of young engineers into research. In this

connection we note that C.S.I.R. has financed research on gas turbines at the Indian Institute of Science, Bangalore and at the Bengal College of Engineering. We have heard of the difficulties in attracting young engineers into research and have made recommendations thereon.

It has been agreed that the Telecommunications Research Institute under the Ministry of Communication should be accommodated in a wing of the National Physical Laboratory. This Institute will cover requirements for research in all subjects relating to telecommunications—Telephones, Telegraphy, etc. and it is very desirable that this work should be in the initial stages along with the National Physical Laboratory. The Defence Science Laboratory is also housed in the National Physical Laboratory's building. The tenure in each of these cases is for a limited period because in course of time with the growth of the work of the National Physical Laboratory for industry further space may be required.

Next, one can question whether the scientific coverage is adequate.

If there is any science which can carry prestige with it more than any other, it would be astronomy. It is a subject employing very few scientists, but they have to be of very high quality. It is a wise policy to foster astronomy and it would be particularly wise at the present time when new techniques are to the fore which do not seem to involve the expense of huge reflecting telescopes. Although it would not seem that direct practical advantages follow on astronomical research, indirectly it has a very potent influence in raising the standard of scientific research work. We consider that full opportunities should be given for astronomical research in India and so to utilise the ability for mathematical analysis and Physical investigation which Indian scientists have shown. It may not be the direct responsibility of C.S.I.R. to look after the future of astronomical research in India, but it could be assisted to develop in one way and another in universities and other centres where astronomical researches are actively pursued.

We note that it is proposed to assist the establishment of meteorological stations. This is also a wise measure as meteorology is another science from which the practical applications may yet become very great.

Geophysics is also a subject requiring special techniques and a centre might be set apart for research in that subject. Apart from its importance to the advance of geological knowledge, particularly the internal structure of the earth, the practical applications are very important in relation to tectonic movement, prospecting for oil and minerals, etc. The discovery of oil resources has the most rapid of all economic effects.

The centres of research provided by the National Laboratories and Institutes in relation to Chemistry and to Physics give quite good

coverage of these subjects when other centres of research are included, such as the Tata Institute of Fundamental Research, the Indian Institute of Science and many university laboratories specialising in different branches of the two subjects, such as the Nuclear Physics Laboratory (Calcutta University) and other laboratories such as the Chemical Technology Laboratories of the University of Bombay. The Dyestuffs Laboratory is partially maintained by funds from the C.S.I.R.

We believe there might be some advantage in having certain far reaching aims in view—aims which though fundamental in character would almost certainly greatly influence the main features of the economy of the nation. The gradual accumulation of knowledge on growth factors relating of plant life would be one such general theme in the realm of chemistry and the search for a means of storing electrical energy through the use of some particles lighter than chemical ions would be an objective in the physical realm which if achieved might lead to tremendous possibilities—developments which will become very much needed when oil eventually becomes scarce.

Atomic energy is well looked after. It is not likely to be neglected, particularly with India's rich resources of monazite and other minerals giving supplies of thorium, uranium, beryllium, titanium etc. The Atomic Energy Commission with a grant of one crore is in control of research and the Tata Institute of Fundamental Research carries out the fundamental research work relating to Nuclear energy, cosmic rays, etc. The latter organisation receives grants from the C.S.I.R. and close touch is maintained between C.S.I.R. and the Atomic Energy Commission. There is also the Institute of Nuclear Physics in Calcutta which receives suitable grants from Calcutta University and C.S.I.R., and now from the Atomic Energy Commission.

In relation to the engineering sciences, which are really mainly applied physics, we have already said something. The question of the possible use of solar energy either direct (by using mirrors, etc.) by photochemical means or biochemical means (*Chlorella,* etc.) is already well to the fore in the programme. This seems well worth concentration of research effort and we note that the application to cooking has already got well towards the production stage. There will be a number of special problems arising, protection against glare, prevention of corrosion of mirrors, storage of the thermal energy, etc. Nevertheless the important use of solar energy would seem to be rather in the direction of its use for cooling large buildings, factories, etc. Roof areas are such that the energy collectable should be sufficient to provide a substantial amount of cooling. The problem is not merely one relating to mechanical engineering; it needs research along with structural engineers, physiologists, etc. The question of comfort in

relation to warmth has been much studied in the West, although temperatures for work in factories and for the home for maximum comfort have been determined and are known, the question of what conditions of warmth are most desirable for the nation in relation to health are not really known and there is scope for much further work. It may be mentioned that it was necessary to carry out a tremendous amount of research work on heating of domestic houses before scientific facts on the comfort question could be established. The same applies very much to the question of cooling in tropical countries and not nearly enough work, in our opinion, has yet been done on the physiological and particularly the building aspects quite apart from the possibility of design and provision of equipment for cooling. Solar energy can also be a means of supplying hot water to houses and building. Here is a whole field of research which might have far reaching consequences.

It is also possible that solar energy could be utilised for power development, for a difference of temperature of 150°C. in a rapid flow of air or vapour might be utilised by means of a turbine with suitable heat exchangers and it should not be beyond possibility to devise means to absorb the energy from solar radiation and impart it to the gases.

Wind power is mainly needed for pumping water in India, but the generation of electric power by wind is also a matter on which there are experiments in various countries and the results are being closely watched by O.E.E.C. However, each country has its own particular problems in this subject so that while taking advantage of the results of various experiments which are being made in different parts of the world, the choosing of suitable sites and the application of the power are matters which depend on the locality. It may also be mentioned that the storage of power by electrolysis of water and subsequent regeneration of the energy through a hydrogen/oxygen electrode cell operated under pressure is being developed and may become useful in connection with the plan to utilise wind power by helping to even out the power obtained.

Similarly the de-salination of water is an important problem, the solution of which engages the attention of several OEEC countries. Advantage could be taken of the information available while continuing experimental work on products such as "Carbion", developed at the Fuel Research Institute (Dhanbad), and other ion exchange media at the National Chemical Laboratory.

India has a vast supply of solar energy, a small fraction of which is fixed by the great volume of food crops and by forests; there are large resources of water which can be diverted to yield power and to

irrigate the soil. The internal market can eventually become enormous. There is little to prevent the great possibilities being realised. Nevertheless, the influence of climate in the past in tropical countries has been severe in reducing efficiency and in causing disease and famine. Through science much is being done to mitigate these effects of climate.

The other sciences—geology, botany, zoology and the 'medical' sciences under which names there are included very many branches of science—are not so closely connected with the work of the C.S.I.R. —but more with medical and agricultural services. Nevertheless, the relationship is fairly close; plant and forest products, and food products are of direct importance to the work of the C.S.I.R. laboratories.

Soil conservation is one of the most important problems with which India is faced. We consider that efforts to conserve, improve and recover the soil of India should be concerted.

It is quite possible that physiological research is being actively pursued in a number of centres, but this we have not encountered and there would seem to be need for full attention to this science; for it bears closely on so many problems, medical, social, managerial and domestic problems of nutrition and of working and home conditions. The work carried out in colder climates is not always applicable to hotter climates and there is probably fundamental knowledge to be acquired by the study of the very intricate physiological processes whereby body temperature is maintained under various conditions.

Genetics is another subject of importance which should be covered.

Another general comment may be made. In India which is so richly endowed by Nature with flora and animal, bird and insect life of great interest, it is good to find that attention is being given to Nature conservancy.

We have no doubt whatever about the value of the work which is going on in the various National Laboratories and Institutes. Already much work has been done which, if the institutes were not in being, would have delayed the rate of general progress in India of today. The value of the work cannot be exactly assessed—no work of that kind can be assessed for the effect of what is done today may be very great a year or so hence. There are already substantial returns arising from the output of the Laboratories [see Section III (d)].

We can pay homage to the work which has been done in such a short time and to the conception of the plan under which it has been accomplished, viz. through the establishment of the C.S.I.R. and the chain of National Laboratories. Every country has to adapt itself to keep abreast of the advance of knowledge and to apply it for the welfare and the betterment of the economic and social conditions of its inhabitants. India, realising that the future of a great nation lies before it and not behind it, has gone forward. No praise is too high for the executive ability with which Dr. Bhatnagar has given shape to the Prime Minister's determination to bring science well to the fore in India's plan for the future. Dr. Bhatnagar, with his broad knowledge of the sciences, his energy and his executive power, has, with the help of those in the great organisation he has set up, in an extraordinarily short period not only provided India with the means by which industry will be helped rapidly to increase, but with the opportunity to attain a very high position among the countries in which science prospers.

ALFRED EGERTON
GASTON DUPOUY
S. N. BOSE
SHRI RAM
M. D. CHATURVEDI
B. R. BATRA
A. L. MUDALIAR

APPENDIX I

Scientific Staff from National Laboratories Deputed Abroad

Laboratory	No. of persons deputed	Country visited	Duration of stay	Grant
1	2	3	4	5
National Physical Laboratory, New Delhi	1	U. S. A.	5-11-51 to 7-8-52	Fulbright Trave Grant and U.S. Government Fellowship
-do-	1	Canada	11-8-51 to 11-8-54	Technical Assistance under Colombo Plan
-do-	1	Australia	15-9-52 to 14-3-54	Colombo Plan
-do-	1	Rhode Island	11-8-52 to 30-9-53	Research Fellowship of Brown University
-do-	2	Australia	3-2-53 to 2-2-55	Technical Assistance under Colombo Plan
-do-	1	West Germany	2-6-53 to 1-6-55	Indo-German Industrial Co-operation Scheme
National Metallurgical Laboratory, Jamshedpur	1	U. K.	27-5-51 to 28-9-51	United Nations Economic Development Fellowship
-do-	1	U. S. A.	9-9-51 to 28-1-52	-do-
-do-	1	Australia	6-11-51 to 14-3-52	-do-
-do-	1	U. S. A.	3-9-51 to 5-11-51	World Metallurgical Congress
-do-	1	U. S. A.	27-2-52 to 17-7-52	United Nations Economic Development Fellowship
-do-	1	U. S. A.	25-8-52 to 24-5-53	-do-

1	2	3	4	5
National Metallurgical Laboratory, Jamshedpur	3	U. K.	7-10-52 to 6-7-53	B.I.S.F. Fellowship under Colombo Plan
-do-	1	West Germany	11-10-52 to 11-10-54	Indo-German Industrial Co-operation Scheme Colombo Plan
-do-	1	West Germany	1-11-52 to 1-11-54	-do-
-do-	1	U. K.	10-8-53 to 10-8-55	Federation of British Industries
-do-	1	Italy	10-11-53 to 7-11-54	Italian Govt. Scholarship
-do-	1	Australia	6-4-53 to 23-5-53	Delegation 5th Mining & Metallurgical Congress
Fuel Research Institute, Jealgora	1	U. S. A.	2-5-51 to 2-1-54	M.I.T.
-do-	1	U. S. A.	22-4-51 to 22-10-51	-do-
-do-	1	U. K.	2-4-51 to 30-9-53 (Absence beyond under consideration)	For Training in Coal Tars
-do-	1	U. S. A.	27-5-52 to 22-12-52	M.I.T.
-do-	1	U. S. A.	26-6-52 to 24-12-52	-do-
-do-	1	U. S. A.	11-6-52 to 21-4-53	Fulbright Travel Grant and U. S. Government Scheme
-do-	1	U. K.	15-9-52 to 15-9-54	Assam Oil Co. Scholarship
-do-	1	Canada	25-7-52 to 3-5-53	U. N. Economic Development Fellowship
-do-	1	U. K.	2-9-52 to 2-1-53	-do-
-do-	1	U. S. A.	26-6-53 to 26-6-54	Smith-Mundt Fulbright Scholarship
-do-	1	U. K.	29-8-53 to 29-8-54	Technology of Coal Washing

1	2	3	4	5
Fuel Research Institute, Jealgora	1	U. K.	1-12-51 to 1-8-54	Imperial College of Science & Technology, London
-do-	1	U. S. A.	10-5-53 to 9-11-53	M. I. T. Summer Fellowship (1953)
Central Drug Research Institute, Lucknow	1	U. S. A.	24-9-51 to 4-12-52	Fulbright Travel Grant & U. S. Government Fellowship
-do-	1	West Germany	8-10-52 to 8-10-54	Indo-German Technical Co-operation Scheme
-do-	1	U. S. A.	3-11-52 to 4-11-54	-do-
-do-	1	U. S. A.	22-8-53 to Sept. 54	Research Associate, National Cancer Institute, U.S.A.
-do-	1	U. K.	17-8-53 to Aug. 54	Nuffield Foundation Fellowship
-do-	2	West Germany	25-4-53 to April 55	Indo-German Technical Co-operation Scheme
Central Food Technological Research Institute, Mysore	1	Canada	12-8-51 to 1-2-52	Technical Assistance Prog. under Colombo Plan
-do-	1	Australia	1-12-52 to 15-1-54	-do-
-do-	1	Australia	11-11-52 to 1-3-54	-do-
-do-	2	Australia	5-3-53 to 4-3-55	-do-
National Chemical Laboratory, Poona	1	Canada	17-12-52	U. N. Technical Assistance Programme
-do-	1	U. S. A.	3-8-53 to 2-2-54	Technical Assistance under Point IV Programme.
-do-	1	West Germany	11-10-52 to 11-10-54	Indo-German Industrial Co-operation Scheme under Colombo Plan

1	2	3	4	5
Central Leather Research Institute, Madras	1	U. S. A.	18-2-53 to 18-2-54	Technical Assistance under Point IV Programme
-do-	1	U. S. A.	25-3-53 to 25-3-54	-do-
Central Glass & Ceramic Research Institute, Calcutta	2	U. S. A.	19-9-53 to 1-1-54	Technical Assistance under Point IV Programme

APPENDIX II

Projects reported to the NRDC to be ready for development

CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE

1. Shell Houses
2. Light Duty Floors
3. Twin-Twisted Steel Bars

CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, KARAIKUDI

1. *Para*-aminophenol
2. Calcium Gluconate (Electrolytic Process)
3. Cuprous Oxide for Anti-fouling Paints
4. Preparation of Secondary Aluminium from Aluminium Scrap
5. Anodising and Colouration of Aluminium
6. Hard Chromium Plating of Locomotive Pistons
7. Electrolytic Preparation of Manganese Metal
8. Potassium Chlorate (Electrolytic Process)

CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE, CALCUTTA

1. Signal Glasses
2. Chemical Porcelain
3. Ceramic Colours and Glazes
4. Replacement of Soda Ash by Salt Cake (Partial) in Glass Manufacture
5. Enamels for Wire-Wound Resistors

FUEL RESEARCH INSTITUTE, JEALGORA

1. Carbion (Zeo-Karbs from Coal)
2. Active Carbons from Coals and Lignites
3. Coalene (Coal tar extraction of Coal bitumens)

NATIONAL PHYSICAL LABORATORY, NEW DELHI

1. Silver Mica Capacitors
2. High Dielectric Constant Ceramics
3. Carbon Brushes
4. Ink Development Project

LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, HYDERABAD

1. Preparation of Potassium Sulphate and White Cement from Felspar
2. Activation of Bauxite for Bleaching and Bodying of Oils
3. Recovery of Benzol from Coal Gas for Lurgi Low Temperature Carbonization Plant
4. Electro-Precipitator for Lurgi Low Temperature Carbonization Plant
5. Distillation Unit for Lurgi Low Temperature Carbonization Plant
6. Ammonia Recovery Plant for Lurgi Low Temperature Carbonization Plant
7. Activated Charcoal from Groundnut Husks
8. Activated Earths
9. Monomeric Dehydrated Castor Oil
10. Fatty Acids
11. Fructose from Cane Sugar
12. Itaconic Acid from Cane Sugar or Molasses
13. Levulinic Acid from Cane Sugar Molasses
14. Calcium Lactate and Lactic Acid from Molasses
15. Alcohol Extraction of Vegetable Oil Cakes and Alcohol-Solvent Mixture Extraction
16. Manufacture of Fire Clay Refractories from Hyderabad Clays
17. Improved Building Bricks
18. Utilization of Cotton Seeds

FOREST RESEARCH INSTITUTE, DEHRA DUN

1. Writing and Printing Papers from Bagasse
2. Writing and Printing Papers from Wattle Wood
3. Newsprint from Bamboo
4. Extraction of Kamla Oil (Patent No. 46338)
5. Preparation of Copper Chlorophyll (Patent No. 47655)
6. Vegetable Proteins for Adhesives
7. Prolamin Adhesives
8. Bamboo Boards
9. Saw Dust Boards
10. Cocoanut Shell Adhesives

11. Pencil Slats from Deodar
12. Red Cutch

CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE, MYSORE

1. Infant and Invalid Foods
2. Orange Juice Concentrates
3. Alcohol and Alcohol-Petrol Mixture Solvent Extraction of Oilseeds and Oilseed Cakes for Production of Edible Flours and Oils
4. Vegetable Milk Curds

INDIAN LAC RESEARCH INSTITUTE, RANCHI

1. Shellac-based Oil-cloth
2. Shellac-based Insulating Cloth (Empire Cloth)

NATIONAL CHEMICAL LABORATORY, POONA

1. Citric Acid
2. Calcium Gluconate (Fermentation)
3. Vitamin C
4. Nicotine Sulphate from Tobacco Waste
5. Dicalcium Phosphate
6. Gelatine (Edible and Photographic)
7. Chlorinated Rubber
8. Mixed Nitrogen Potash Fertilisers
9. Semi-acidulated Kotka Phosphate
10. Mixed Nitrogen Phosphorus Fertilisers
11. Modified Oils for Paints and Varnish from Tobacco Seed and Safflower Seed Oils
12. Metallic Salts of Fatty Acids as Varnish Resins
13. Air-drying Wrinkle Finish Coating Compositions
14. Recovery of Nickel and Fat from Spent Nickel Catalysts
15. Production of Photographic Emulsions using Indigenous Gelatine
16. Production of Plain and Wrinkle Stoving Finishes

INDIAN INSTITUTE OF SCIENCE, BANGALORE

1. Acid-resistant Steel Enamelling Compositions
2. Electro-chemical Manufacture of Alkali or Alkaline Earth Hydrosulphites (Hyposulphites)
3. Upgrading of Minerals

4. Manufacture of Phosphoric Acid and Phosphatic Fertilisers from Rock Phosphate (or Phosphatic Nodules)
5. Upgrading of Low Grade Manganese Ores
6. Chlorination of Minerals by the Use of Ferric Chloride as Binding Material
7. Manufacture of Guanidine Derivatives
8. Manufacture of Bis (1-aminophenyl)-sulphone
9. Enriching Vitamin Contents of Groundnuts or similar Foodstuffs
10. Production of Bacterial Diastase
11. Preparation of Insulin
12. Dust-separating Devices
13. Head-transfer Devices
14. Gas Turbine Power Plant
15. Gas Producer Power Plant
16. Thermal Power Plant
17. Two-stroke Compression Ignition Engines
18. Compression-ignition Internal Combustion Engines
19. Prototype Manufacture and Further Development of a U-type Two-stroke Diesel Engine
20. Prototype Manufacture and Further Development of a Two-Stroke Diesel Engine with Self-induced Fuel Injection
21. Development of Twin Fuel Diesel Engines to accept Indigenous Fuels with Normal or Heavy Fuels, especially Power Alcohol
22. Constant Current Transformer
23. Measurements of Loss of Small Sheets
24. Carbon Type Resistors
25. New Type of Slide Rule
26. Grading of Rubber Compounds and the Determination of Curing Time
27. Control of Successive Different Operations Using a Single Pole Single Throw Switch
28. Static Ringing Converters

APPENDIX III

National Research Development Corporation of India

Preliminary—With the establishment of a chain of national laboratories and the quickening tempo of research, development of laboratory researches to commercial production assumed increased significance. So far the Industrial Liaison Committee, which deals with patents and processes arising out of researches sponsored by CSIR and the Patents Advisory Committee, which is concerned with the exploitation of government owned patents, have been responsible for this work but it has been obvious for some time that the gap between research and development is a wide one and to bridge it effectively a specialised organization devoting itself exclusively to this work is necessary. The CSIR had proposed the setting up of a National Research Development Corporation of India for this purpose on the lines of a similar Corporation established in U.K. in 1950. This recommendation was supported by the Planning Commission which advocated its early acceptance. The proposal was accepted by the Cabinet on April 15, 1953 and it was decided that finances for the Corporation should be provided by Government in the form of a long dated loan, free of interest during the first few years or carrying a low rate of interest. Thereafter it was decided that the Corporation should be constituted as a government owned private limited company under the provisions of the Indian Companies Act, 1913. A Committee composed of the following, with a whole time Secretary, was constituted to initiate and complete all preliminary work in connection with the setting up of the Corporation. A sum of Rs. 50,000 was placed at its disposal as an advance to meet the expenses.

1. Shri Kasturbhai Lalbhai	Chairman
2. Dr. S. S. Bhatnagar	Member
3. Lala Shri Ram	"
4. Dr. V. Sarabhai	"
5. Shri P. A. Narielwala	"
6. Shri M. D. Chaturvedi	"
7. Shri M. S. Bhatnagar	"
8. Dr. S. D. Mahant	Secretary

The Committee held three meetings. At the first two meetings of the Committee, held in August 1953 and September 22, 1953, the memorandum and articles of association of the proposed Corporation

drafted by the Secretary, were considered and approved, subject to certain modifications. At the third meeting held on November 23, 1953, the Committee considered 15 projects for development.

Registration—The memorandum and articles of association were finalised after obtaining the comments of the Ministries of Law and Finance. A licence under Section 26 of the Indian Companies Act was issued by the Government of India on November 27, 1953 for its registration as a limited liability company without the addition of the word "limited" to its name and the Corporation was registered in December 1953.

Objects—The main objects of the Corporation as laid down in the memorandum of the association are:

(a) to develop and exploit in the public interest for profit or otherwise:

  (i) inventions, whether patentable or otherwise, of the Council of Scientific and Industrial Research including technical and engineering 'know how' of processes;

  (ii) patents and inventions of different departments of Government of India and State Governments, commodity research committees, and other statutory research organizations, including technical and engineering 'know how' of processes;

  (iii) such other patents as may be voluntarily assigned, by general or special agreement, by universities, research institutions or individuals; and

  (iv) such other processes and patents, the development of which may be entrusted to the Corporation by Government of India.

(b) to enter into reciprocal arrangements with similar organizations in other countries to exploit Indian inventions in these countries and their inventions in India;

(c) to issue exclusive and/or non-exclusive licences on such terms and conditions regarding payment of premia, royalties, share of profits and/or any other basis as are considered advisable to commercially develop the invention and ensure commercial production of the products of inventions;

(d) to secure co-operation of such state-owned or state-controlled industries or any units thereof as are deemed or are likely to be interested or necessary to develop the

new processes or invention and reimburse such industries any loss that they may incur;

(e) to enter into agreement with a private firm or firms to develop inventions by trials at their works and to reimburse them any loss that may be incurred during these trials;

(f) to instal and work pilot, prototype or semi-scale units or full commercial plants to develop a particular invention or inventions and ensure production from such invention or inventions, to sell or otherwise dispose of the products of such inventions on payment or otherwise and generally on such terms and conditions as may be deemed fit;

(g) to transfer by sale, lease, hire or otherwise dispose of any pilot plant, protoype plant, semi-scale plant or full commercial plant to any firm, individual, association or institute and entrust the same with commercial production of any products of invention or inventions for which the plant or plants had been installed on such terms and conditions as may be deemed fit;

(h) to afford facilities for advising and assisting government departments, universities, research institutions and individuals in filing applications for patents and prosecuting the same before the Controller of Patents and to frame rules for the purpose and to vary them from time to time;

(i) to distribute a share of profits, premia and/or royalties from any particular invention or inventions to government departments, institutions, organizations, universities, or individuals from whom such invention or inventions were received and to frame rules for the purpose and vary them from time to time;

(j) to reward, in special circumstances, any particular invention or inventions by gifts, rewards, *ex gratia* payments or in such other manner as may be deemed fit.

Finances—The authorised capital of the Corporation is Rs. 1 crore divided into 10,000 shares of Rs. 1,000 each. Government has agreed that the Corporation should have a subscribed capital of Rs. 10 lakhs (1,000 shares of Rs. 1,000 each) of which Rs. 5 lakhs will be paid during 1953-54 and Rs. 5 lakhs in 1954-55 when the shares will become fully paid up. Any further finances required by the Corporation will be made available in the form of a loan.

Management—The following have been nominated to constitute the first Board of Directors for a period of three years:

1. Shri Kasturbhai Lalbhai	Chairman
2. Lala Shri Ram	Director
3. Dr. S. S. Bhatnagar	"
4. Dr. V. Sarabhai	"
5. Shri P. A. Narielwala	"
6. Shri M. D. Chaturvedi	"
7. Shri M. S. Bhatnagar	"

Developmental activities—To obtain preliminary information, circular letters were addressed to 18 research institutions requesting them to furnish information about projects awaiting development with them. Replies from 14 institutions reporting 103 processes were received. These are now under examination and further information required is being obtained to decide the order of priority for their development.

Development of CSIR patents and processes—In agreement with CSIR and the Ministry of Commerce and Industry, it has been decided that the basis for taking over the work relating to and development and exploitation of CSIR patents and the transfer of work of the Industrial Liaison Committee would be the assignment of present and future inventions by CSIR to the Corporation. Patenting of inventions and renewal of patents would, however, continue to be the responsibility of the research organization. It has been agreed that NRDC would take the work in hand immediately pending execution of necessary documents and completion of legal formalities.

It has also been decided that development of Government inventions and patents from research institutions, universities and individuals will be undertaken by the Corporation on the same basis.

The following procedural details have been agreed upon:

1. Filing of patent specifications and renewal of patents	CSIR
2. Examination of technical and economic aspects of processes and compilation of Non-technical Notes	CSIR in consultation with NRDC

3.	Publication and circulation of Non-technical Notes	NRDC in consultation with CSIR & Development Wing (Min. of C. & I.)
4.	Negotiation and licensing	NRDC
5.	Progressing developments	NRDC
6.	Collection of royalties	NRDC
7.	Disbursement of royalties to workers	CSIR

(a) The Directors of laboratories will be at liberty to explain the significance of scientific and technical aspects of a process to parties likely to be interested in undertaking its commercial development but the parties concerned will be referred to NRDC for discussion or negotiation of terms for exploitation rights.

(b) NRDC will maintain direct liaison with national laboratories and copies of progress reports of laboratories will be supplied to NRDC so that they may be kept informed of progress of investigations in which they are interested.

(c) NRDC will correspond direct with national laboratories to obtain information required for compilation of Non-Technical Notes, copies being endorsed to CSIR.

(d) The question of apportionment of royalties will be decided later in the light of experience.

(e) All existing agreements will be transferred to NRDC.

(f) Income by way of premia and royalties will be credited to NRDC funds.

Exploitation of Government patents—The procedural details for taking the work connected with exploitation of government patents are under discussion with the Ministry of Commerce & Industry.

General principles for taking up development of projects—For the consideration of projects reported for development, the following general principles have been laid down:

1. While research laboratories should no doubt extend their laboratory investigations up to the pilot plant stage where necessary and dispose of the products of such pilot plant experimentation by sale or otherwise, no laboratory should be encouraged by NRDC to undertake manufacture of a product as a part of its routine activities.

2. Where any industrial concern agrees to bear the cost of setting up a pilot plant and to afford facilities for the conduct of pilot plant trials and to provide facilities at the firm's own cost to a research institution, it may be permitted to use the results of research free of any royalties for a fixed period (to be negotiated in each case). The results would be the property of research institutions and the Corporation will be at liberty to make these available to other parties on such terms and conditions as are considered reasonable, the industrial concern supplying detailed reports to the research institutions and ensuring that they are kept confidential and are not divulged to unauthorised parties. The firm will have no claims to royalties or other income accruing from the exploitation of research results.

APPENDIX IV

Scientific and Research Institutions in India

INSTITUTIONS ETC. WHICH COME WITHIN THE PURVIEW OF THE MINISTRY OF NATURAL RESOURCES AND SCIENTIFIC RESEARCH

1. Tata Institute of Fundamental Research, Bombay
2. Physical Research Laboratory, Ahmedabad
3. Institute of Nuclear Physics, Calcutta
4. Institute for Radio Physics and Electronics, Calcutta
5. Indian Association for the Cultivation of Science, Calcutta
6. Survey of India, Dehra Dun
7. Botanical Survey of India, Calcutta
8. Zoological Survey of India, Calcutta
9. Geological Survey of India
10. Indian Bureau of Mines
11. Indian School of Mines and Applied Geology, Dhanbad
12. Bose Institute, Calcutta
13. Birbal Sahni Institute of Palaeobotany, Lucknow
14. Central Laboratories for Scientific and Industrial Research, Hyderabad (Deccan)
15. Jiwaji Industrial Research Laboratory, Gwalior

RESEARCH ASSOCIATIONS

1. Silk and Art Silk Mills Research Association, Bombay
2. South India Textile Research Association, Coimbatore
3. Ahmedabad Textile Industry's Research Association, Ahmedabad

OTHER RESEARCH INSTITUTIONS

1. Shri Ram Institute for Industrial Research, Delhi
2. Tisco Research and Control Laboratory, Jamshedpur
3. Sir Profulla Chandra Research Laboratory, Calcutta
4. Indian Institute of Science, Bangalore
5. Indian Academy of Sciences (Raman Institute), Bangalore
6. Research Department, All India Radio, Delhi
7. Institute of Psychological Research and Service
8. Imperial Chemical Industries (I.C.I.) Laboratories

9. Ramanujan Institute of Mathematics
10. The Indian Statistical Institute, Calcutta
11. India Meteorological Department, New Delhi
12. The Solar Physics Observatory, Kodaikanal
13. The Drug Research Laboratory, Jammu and Kashmir, Jammu Tawi
14. Nutrition Research Laboratory, Coonoor

AGRICULTURAL RESEARCH

15. Indian Agricultural Research Institute, New Delhi
16. Central Rice Research Institute, Cuttack (Orissa)
17. Central Potato Research Institute, Patna (Bihar)
18. Indian Dairy Research Institute, Bangalore
19. Indian Veterinary Research Institute, Muktesar and Izatnagar
20. Indian Institute of Sugar Technology, Kanpur
21. Forest Research Institute, Dehra Dun
22. Central Marine Fisheries Station, Mandapam
23. Central Inland Fisheries Research Station, Calcutta
24. Deep Sea Fisheries Station, Bombay
25. Sheila Dhar Institute of Soil Science, Allahabad
26. The Institute of Plant Industry, Indore
27. Horticulture Research Station, Sabour (Bihar)

COMMODITY RESEARCH ORGANISATIONS

1. Indian Central Cotton Committee, Bombay
2. Indian Central Oilseeds Committee, New Delhi.
3. Indian Central Jute Committee, Calcutta
4. Indian Jute Mills' Association Laboratory, Calcutta
5. Indian Central Coconut Committee, Kasaragod
6. Indian Central Sugarcane Committee, New Delhi
7. Sugarcane Breeding Institute, Coimbatore
8. Indian Tea Association Research Station, Tocklai (Assam)
9. Indian Central Tobacco Committee, Rajamundri, Pusa, Anand
10. Indian Central Arecanut Committee, Kozhikode
11. Indian Lac Cess Committee, Ranchi
12. Central Silk Board
13. Indian Rubber Board, Kottyam
14. Indian Coffee Board

APPENDIX V

Statement giving the recurring expenses of the ATIRA and the amount paid by the Government during 1949-50, 1950-51 and 1951-52

	*Actual recurring expenditure	Government share @ 50 %	Actual payment	Amount paid in excess (+) or amount due to ATIRA (—)	
	Rs.	Rs.	Rs.		Rs.
1949-50	93,667-11-4	46,838-13-8	50,000-0-0	(+)	3,161-2-4
1950-51	2,63,575-7-3	1,31,788-3-6	1,09,338-13-8	(—)	22,449-5-10
1951-52	3,13,249-15-9	1,50,000-0-0	1,31,788-3-6	(—)	18,211-12-6
		Total due at the end of 1951-52			37,500-0-0

*Depreciation amount has not been included in the recurring expenditure, which is Rs. 5,206, Rs. 24,284 and Rs. 41,956 for 1949-50, 1950-51 and 1951-52 respectively.

GIPD—LAD—46 CP—25-8-54—1,000